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OFFICE, ELECTRIC DEPT.

COOLING CONDENSING WATER

BY R. T. STROHM.

Under favorable conditions the gain to be secured by using a condenser in connection with the steam engine or turbine is considerable. Such conditions obtain when there is a large and convenient supply of water at hand which may be used, without great expense, for condensing purposes. Usually, a power plant located near a stream or a lake is run condensing, since the cooling water supply is ample and may be obtained for the mere cost of pumping it.

On the other hand, if a power plant is located in such a place that there is no natural reservoir of water near by, so that all water must be brought from a distance or taken from city mains, the advisability of using condensing apparatus becomes a matter of no little doubt.

For example, an electric central station at one time installed a new power unit in the shape of a turbine. The manager had been led to believe, by all that he had read and heard, that a turbine must be run condensing to insure the greatest economy. Consequently, a complete condensing outfit was included, despite the fact that the water for condensing purposes had to be purchased from a city water company. It took six months of operation under such conditions to prove to the manager that the scheme was wholly wrong. The condenser was abandoned, and the turbine run non-condensing, with satisfactory economy, inasmuch as the fuel used was of a low grade and plentiful in amount.

The water required to condense one pound of exhaust steam varies in amount, according to the pressure of the steam and the temperature of the cooling water. However, under ordinary conditions there are required 20 to 30 pounds of water per pound of steam. In a plant of even moderate size, therefore, the condensing water required would be of considerable amount, and if taken from city mains would be quite an item in the operating expenses of the plant.

The problem confronting an engineer under such conditions as have just been enumerated, is to gain all the benefits that may be derived from condensing, even with no natural source of water supply at hand, and yet avoid excessive water rentals. This problem has been met and solved, in a large number of cases, by the use of systems in which the condensing water, after absorbing the heat of the steam, is cooled and then sent again through the condenser to take up further heat, the process being continued indefinitely. In this way the cost of cooling water is kept down to such a figure as to make condensing economical.

Without doubt the simplest of the cooling devices for reducing the temperature of condensing water is a large open pond, built of earth or cement. The hot water from the condenser is allowed to flow into this pool at one end, and the suction of the circulating pump is located near the opposite end of the pond, so that the water shall travel as far as possible before being used again, thus giving time for it to lose much of its heat.

It is evident, however, that the capacity of the pond would need to be large, in comparison with the rated capacity of the power plant, for the most of the cooling is done by the contact of the extended surface of the water with the air, little of the heat passing away through the bed or side walls of the pond. Now, in a locality where land is expensive, such a system would be altogether impracticable, since the requisite area could not be secured; or, if available, would completely overshadow any saving due to the system.

Besides these, there are other objections. It would be a difficult matter to keep an open pond perfectly clean and free from refuse and vegetable matter, the presence of which would, sooner or later tend to clog the intake to the condenser and result in annoyance and trouble. Also, a plain earth pond, as commonly constructed, is subject to leakage, and must be carefully watched on this account. In some soils the construction of a dug pond would be out of the question, owing to the porosity and looseness of the earth, as the leakage would be excessive.

In view of the shortcomings of this type of cooling device, it is not surprising that methods of improving it were soon devised. The first step was to substitute parallel tiers of horizontal trays for the pond, in that way presenting a great surface to the cooling action of the air. The advantage to be gained by this arrangement is the saving in superficial area of land required. However, the objections of the pond still exist. That is, the trays are likely to develop leaks and may become fouled, while the cost of construction of the system is large.

Realizing that greater efficiency of cooling was possible with greater surface exposed to the air, the next step was the intro-

duction of a spraying device, by which the heated water was thrown into the air in a finely divided form, later falling into a tank or reservoir from which it is drawn to the condenser.

The principle of the spraying device—that of splitting up the water so as to have the most intimate contact with the air—forms the basic idea in the many forms of cooling towers that are now used to reduce the temperature of condensing water. The modern cooling tower is a cylindrical shell of iron, in outer appearance much resembling a short, stocky chimney. Inside the shell are placed sheets of iron or other forms of iron, by which the water, entering at the top of the tower, may be broken up into a large number of little streams or sheets, as it falls by gravity to the bottom of the tower. The air by which the cooling is effected is admitted at the base of the cooling tower and passes upward, mingling with the water, and thus performing the desired service.

Cooling towers are of two distinct forms. In one form the air is forced up through the tower by a fan at the base, the circulation thus being positive and capable of regulation. In another form the air circulates upward by the same principle governing the action of a chimney; that is, the warm column inside the shell ascends while the heavier colder air outside enters at the bottom. This method of natural draft is the least expensive way of obtaining the necessary air circulation, since it does away with the power needed to operate the fan used in the other types.

A representative form of modern cooling tower is shown, for the greater part in section, in Fig. 1. The shell *a* rests upon a concrete foundation, *b*, that surrounds a tank, *c*, beneath the tower. For a short distance above the level of the foundation the shell is lined with brick, *d*, this brickwork forming a support for an iron grating, *e*, that fits inside the shell. On the grating are placed many short, hollow cylindrical tiles, *f*, as indicated, these tiles being set on end and so arranged that each tile in an upper tier rests upon two or three in the next lower tier.

The hot water from the condenser is pumped through the pipes *g* and *h* to the top of the tower. Here it enters the distributing pipe, *i*. There are four of these pipes, placed so as to form a cross, like a plus sign, and screwed into a fitting, *j*, that is placed around the central pipe, *h*, in such a way as to be free to rotate in a horizontal plane. Each of the pipes, *i*, is perforated along one side by a number of openings. Consequently, when the hot water is pumped into the pipe, *h*, it flows into the distributing pipes, *i*, and, escaping through the perforations in these pipes, causes the cross to rotate. The principle is the same as that which forms the basis of the common Barker's mill. The hot water is thus distributed over the whole upper layer or tier of tiles. It then trickles down through the first tier to the second, where it is again broken into different streams, and so on to the bottom, where it falls into the collecting tank, *c*. From the bottom of the tank it is conveyed by the suction pipe, *k*, back to the condenser. The pipe, *l*, is an overflow pipe, to prevent the tank, *c*, from becoming too full and overflowing the foundations, *b*.

An air fan, *m*, inserted in a casing near the bottom of the tower and driven by belt from an engine or motor, furnishes the requisite air circulation, the air being deflected upward into the shell by the curved plate, *n*. Thus the air current moves upward through the tiers of tiles, meeting the down-coming water, and peforming the cooling.

In other styles of cooling towers the water is divided into thin sheets or streams by various means. In one, a large number of galvanized wire screens are hung vertically in the tower. These hold much water and present a great amount of surface to the air. In another type wooden slats, on the order of slatted blinds, are used. In still another form galvanized iron sheets are hung beneath a perforated tray in the top of the tower. In yet another the breaking up of the condensing water into films is accomplished by layers of iron pipes placed at right angles to one another.

The cooling effect of the air is not due merely to the fact that the air increases in temperature as it mingles with the hot

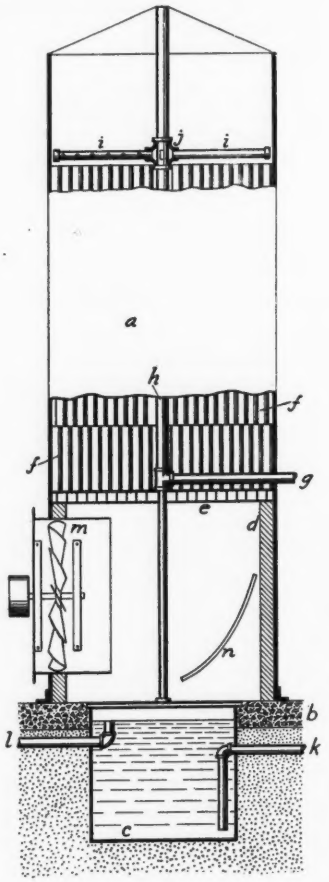


Fig. 1.

water, though, of course, there must be some cooling due to this; for, as the air takes up heat, the water becomes less warm. However, a far more important action is the evaporative effect of the air circulation.

It is well known that if a dish of water is set in the open air, it will be only a short time before the water will disappear. The disappearance is due to evaporation, the water passing off into the air in the shape of vapor; but in order to convert a pound of water into vapor, heat is required, just as truly as it requires heat to convert water into steam in a boiler. It takes 966 British thermal units to vaporize one pound of water at 212° Fahr. In round numbers, it requires something like 1,000 thermal units to cause the vaporization of one pound of water at ordinary temperatures under atmospheric pressure. Hence, the evaporation of two pounds of water is suf-

ficient to lower the temperature of a ton of water one degree.

Such is the action of the cooling tower. The air current, in passing upward through the falling water, hastens the evaporation. The source of the heat that causes this evaporation is the water itself. Consequently, as a portion of the warm condensing water changes to vapor, the temperature of the remainder is lowered.

The rate at which this evaporation takes place will depend largely upon the dryness of the air, the amount of water surface exposed and the volume of air circulated. It is also true that the temperature of the air affects the rate of evaporation. Warm air will absorb a greater amount of water vapor than will cold air. Also, dry air will naturally take up moisture more extensively and rapidly than air which is almost saturated. As a result, it may be expected that cooling will occur more rapidly, in a fan tower, during a warm day in summer, if the air is dry, than during a winter day, in spite of the lower temperature of the air in the latter case.

Assume, for example, a station of 400 horse power, having engines using 20 pounds of steam per horse power per hour. There will be 8,000 pounds of exhaust steam per hour, and if each pound of steam requires 36 pounds of water, there will be required 288,000 pounds of cooling water per hour. Let it be further assumed that the temperature of the water leaving the cooling tower is 90° F., and the temperature of the water entering the tower is 130° F. The cooling tower thus accomplishes a reduction in temperature of the cooling water of 40 degrees. To cool 288,000 pounds of water 40 degrees, there must be 11,520,000 heat units given up. As it requires the evaporation of one pound to take away 1,000 heat units, it will be necessary to vaporize 11,520 pounds of water to give the desired cooling effect. This is 4 per cent. of the total amount passing through the tower. On the basis of the rated power of the plant, it means about 29 pounds per horse power per hour.

The strong draft created by a fan, giving forced circulation, will make a greater loss, owing to the carrying power of the current. In the case of natural draft, the loss will probably be less. Of the two systems, however, the fan tower requires only about half the water-exposing surface that is needed in the natural draft tower for the same work.

In determining the advisability of using a cooling tower, it must be remembered that power is required to run the air fan, and also to pump the water to the distributing device at the top of the tower. Take the example cited above, and assume that the cooling water must be lifted to a height of 50 feet. The work done per hour would then be 14,400,000 foot-pounds, or 240,000 foot-pounds per minute, equivalent to 7.3 horse power. Adding 35 per cent. for friction and other losses, the total power expended on the tower is about 10 horse power, or 2.5 per cent. of the power of the entire plant.

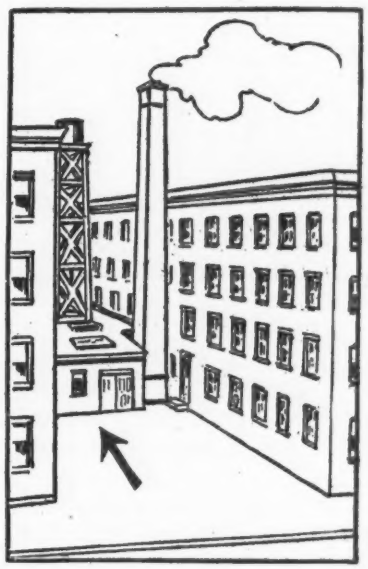
BOILER EXPLOSION AT LYNN, MASS.

Fifteen Injured and $500,000 Worth of Property Destroyed

As a result of a boiler explosion in the shoe factory of the P. J. Harney Co., at Lynn, Mass., fifteen persons were more or less seriously injured and property to the extent of about $500,000 was destroyed by the resulting fire. It was shortly before 7 o'clock, on the morning of December 6th, that the explosion took place, and, like most boiler explosions, there are dozens of rumors to account for the accident.

The boiler room of the Harney shoe factory, in which the explosion occurred, was located between the main building of the factory and an adjoining box factory, the Harney boilers supplying steam to both plants. At the moment of the explosion it is said that W. J. Dunning, the engineer, was alone in the boiler room, and about twenty employees were in the factory. As near as is known, the boiler exploded at 6.55 A. M., and had the explosion occurred ten minutes later it is probable that there would have been severe loss of life among the hundreds of employees who had not arrived. The engineer had started the fires and was ready to turn the power on, when the boiler exploded. Pieces of the boiler were blown through the front of the building, and the *débris* immediately caught fire, destroying, besides the P. J. Harney shoe factory, the Tufts and Friedman shoe factory, the H. P. Hood Creamery, the Boston & Maine West Lynn railroad station, the J. H. Owens box factory, the New York Shoe Company and the R. Y. Russell box factory. It was one of the worst fires in the history of the city, as all the buildings were of frame construction and the high wind blew the sparks in all directions.

The boiler itself was not blown from the engine room. It exploded, wrenched itself loose from its supports, rose in the air and settled back in a tangled mass of pipes, valves and boiler sheets. The doors of the boiler were blown through the front of the boiler house, and were found one hundred



Arrow points to Engine Room where Boiler was located

yards away. The front and roof of the boiler house were blown out and up into the air. The force of the explosion blew out the side of the Harney factory, and at the same time

crushed in the side of the Owens box factory across the alleyway that led to the boiler house.

The boiler, during the night, was looked after by a watchman who cared for a number of boilers in the neighborhood, and the engineer said it was all right in the morning when he took charge. After his marvellous escape the engineer is quoted as having said: "While I was getting up steam for the day's work, shortly before 7 o'clock, there came a terrific explosion, which sent me reeling toward the wall and then throwing me heavily to the ground. I managed to get to my feet and started for the street. I have no idea what caused the explosion, as the boiler was tested within the year and found to be in good condition. The only thing I can think of is that a defective plate gave way or that some pipe became plugged up."

The boiler which exploded was not subject to State inspection, as it was insured by the Hartford Insurance Co. and regularly inspected by them. Professor Miller, of the Massachusetts Institute of Technology, was early on the scene of the explosion, and made an inspection on behalf of the insurance company.

The boiler which exploded was made in September, 1895, by the Cunningham Iron Works, of South Boston. It was of the horizontal lap seam tubular type of boiler, 72 inches in diameter and 18½ feet long. It was made in three courses of ⅜-inch steel plate having a tensile strength of 60,000 pounds per square inch. It contained ninety-two 3½-inch tubes, none of which had ever been renewed; eight 1¼-inch through braces upset to 1½ inches; two diagonal 1-inch braces on each head; also two channel irons, 6 x 2½ x ½, and one angle iron, 4 x 3 x ½, on each head. Four of the through braces broke on the inside of the outside nuts, the remaining being broken on the outside of the inside nuts. One of the diagonal stays broke at the palm; the other sheared the rivets.

The rear head of the boiler—taking with it all tubes and rear course—was blown from its setting through a partition wall to within a few inches of the cylinder of engine. The front head—taking with it the front course of boiler—was blown to the left through the division wall into the adjoining Owens building. This part of the boiler was not found until a week after the explosion. The centre course of the boiler shell seems to have been blown clear upward, and to have fallen back almost to the same place where the boiler had formerly stood. It gave way at the seams excepting in two places, where pieces of rear and front courses weer torn out. The safety valve, which is supposed to have been a "pop", has not yet been found. The fusible plug was found and showed probable indications that it melted by the intense heat of the fire after the explosion. The only parts of the boiler blown to any distance from the seat of the explosion, were a piece of the boiler front and the smoke connection. The boiler was inspected last May and was allowed 95 pounds pressure, at which the safety valve was set, the average pressure used being 85 pounds.

Ruins of the Engine Room, showing wrecked Corliss Engine and Boiler

How Dunnan, the engineer, ever escaped with his life is a wonder. He is still in the hospital, carefully guarded, so that what was going on in the boiler room and what the engineer was doing at the time can only be surmised. He is, however,

practically exonerated from all blame by the indications of the fusible plug.

In connection with the explosion there have been various opinions and explanations advanced. Chief Inspector Noyes, of the Hartford Co., is reported to have said: "It is not true that any defect in the boiler at the Harney shoe factory in Lynn was ever discovered by us or reported to us. The boiler was regularly inspected on May 6th last, both inside and outside, and no imperfection was discovered.

"The boiler was of 1895 make. It was inspected by men

View of the Tubes, which all remained in Rear Head. The Front Head, Middle Course, and Front Course were blown away. State Inspector McNeill in foreground

as well qualified for this work as any in Massachusetts. We are not now prepared to say that the initial point of the explosion was in the lap seam until the section now buried under the chimney has been dug out. The point cannot be determined because the crack mentioned near the manhole may have been incidental to the explosion and not the initial point. Much remains to be considered, investigated and determined."

It is the purpose of the boiler inspectors and experts in Massachusetts to ask the next session of the State Legislature, which meets in January, to pass new and more thorough boiler inspection laws.

The consensus of opinion is that the new law should make it obligatory that hydrostatic tests of all boilers in the State be made, and if possible to condemn all lap-seam boilers, and if possible prohibit entirely the use of the lap-seam boilers.

One of the former chief inspectors of the State, Mr. Hawley, upon visiting the boiler after the explosion, described the boiler and the cause of the explosion as follows:

"I went to Lynn and looked over the ground on the site of the explosion. The boiler which was responsible for the disaster was made of three courses, was seventy-two inches in diameter and of three-eighths inch steel plate. The middle course exploded and was flattened out, but it had not moved from its position in the setting course. This part of the boiler was the one mainly responsible for the explosion.

"The back tubes I found had moved about eight feet into the engine room. The front course had not been found on account of it being under the *débris* nearby.

"Workmen were uncovering the middle sheet when I got there, and when it was uncovered it disclosed a crack the whole length of the longitudinal seam, about six feet long. It sheared the rivets on both sides of girth seams and tore into the plate a considerable distance on each side.

"Attached to this sheet was a portion of the front sheet. The first course along its longitudinal seam was cracked in exactly the same manner as the longitudinal seam of the second course. The longitudinal seam on the rear course also shows evidence of a fracture along the lap.

"The fusible plug was found to be in good condition, which indicates that there was plenty of water in the boiler at the time.

"The safety valve had not been found, but I was assured by the engineer in the adjoining room that he had heard the safety valve blowing off several times the day before, which would indicate that the safety valve was in good condition.

"The throttle of the engine was found to be closed, showing that the engineer had not started the engine, indicating that there was no sudden shock, such as commonly precipitates such explosions. The conclusion therefore derived is that the plate was cracked to such an extent that it gave way under a steady pressure without shock. At the time I left the State inspectors were hunting for the front sheet.

"When boilers with lap-seams are built, the plates are rolled as nearly circular as possible; but when they leave the rolls there is an over-lapping portion that the rolls cannot bend down. This over-lapping end must be pounded down by heavy hammers while the metal is cold, and the rough usage undoubtedly starts a crack.

"When the joint is completed the plates do not form a true circle, but when in use the pressure forming a circle distorts the plate at the stiff joint and continuous bending back and forward with the pulsation of the boiler deepens the crack until it extends clean through the boiler. The difficulty of detection lies in the fact that the crack is underneath the seam

Rear Sheet of Boiler. Chief Inspector F. S. Allen of Hartford Co., and Inspector C. J. Stoddard of the Employers Liability Assurance Co. making examination

and commonly not visible inside or outside until the crack extends in some one place clean through.

"Boilers to run at 100 pounds pressure are designed not to explode under 450 pounds of steam. Therefore this crack could extend completely through the three-eighths inch steel plate for a short distance and give warning without the boiler

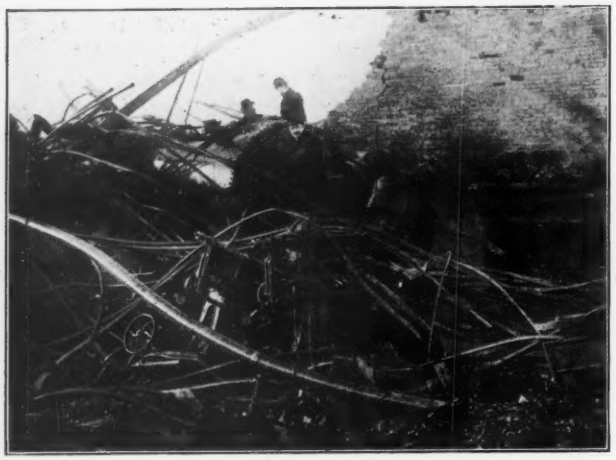
exploding at the 100 pounds pressure carried.

"It is more than possible that if the hydrostatic test had been applied to the boiler which exploded in Lynn, just previous to its starting, that it would have uncovered this defect.

"The State inspectors now have reported to them a test of all boilers insured and whether they are lap-seamed or not; but they have no definite authority to inspect such boilers.

"As the law now stands, if the State inspectors were morally certain that a boiler was in a dangerous condition and run at excessive pressure, they would have no authority to prohibit its use if an insurance company could be found ready to insure it, for once a boiler is insured it is taken out of the hands of the State inspectors. I have said before and I say now, this is not right. They should have authority to condemn a boiler and prohibit its use when they morally know that it is endangering the lives of people daily."

The new law which was recently passed by the State of Massachusetts governing the inspection of boilers in Massachusetts, was the direct result of the boiler explosion at Brockton, Mass., which occurred on March 20, 1905, in which fifty-five persons lost their lives. This law follows:



Rear Head of Boiler. State Chief McNeill, Inspector Hinckley and Adiuster Blake of the Hartford Insurance Co., Making Examination

Chapter 521—An act to provide for the appointment of a chief inspector of the boiler inspection department of the district police.

Be it enacted as follows: Section 1. The Governor is hereby authorized to appoint, as hereinafter provided, one of the members of the boiler inspection department of the district police as chief inspector of said boiler inspection department. Said chief inspector shall have supervision over the members of said boiler inspection department in order to secure the uniform enforcement throughout the Commonwealth of all acts relative to the inspection of boilers and the examination of engineers and firemen.

Said chief inspector shall receive an annual salary of $2,000 and his actual and necessary traveling expenses.

Section 2. As soon as practicable after the passage of this act, the civil service commissioners shall hold an examination to determine the qualifications of applicants for the position of said chief inspector. The commissioners shall certify to the Governor the names of the three persons receiving the highest percentage on such examination, and the percentage obtained by each, and the Governor shall appoint one of said three persons as chief inspector of the boiler inspection department.

Section 3. This act shall take effect upon its passage. (Approved June 26, 1906.)

Chapter 522—An act relative to the inspection of boilers:

Be it enacted as follows: Section 1. The Governor is hereby authorized and directed to appoint five additional members of the inspection department of the district police, who shall be not above forty-five years of age. Said age limit shall apply to all new appointments to said boiler inspection department, but shall not apply to any reappointment thereto. They shall be detailed for the inspection of boilers and shall receive the same compensation now received by the present inspectors of boilers.

The Governor is also hereby authorized to appoint a clerk, at an annual salary of $800, to do service in said department, and four additional clerks at an annual salary of $600 each, to serve at branch offices in said department.

Section 2. Upon every boiler which has been inspected and approved by the district police, or upon the fittings of the said boiler, there shall be attached by the said inspector, by a seal or otherwise, a metal tag, and upon the tag or seal shall be inscribed the number of the boiler, the year, month and date of the inspection, and the number of the district.

Section 3. Any person excepting a member of the District Police who defaces or removes the tag or seal specified in Section 2, shall be punished by a fine of not less than five nor more than one hundred dollars. (Approved June 26, 1906.)

Under this law Joseph H. McNeill was appointed chief of the boiler inspection department two months ago by Governor Guild.

The following five additional boiler inspectors were appointed by the Governor: J. Walter Evans, Frank C. Hinckney, George A. Luck, Justin A. McCarthy and Herbert A. Sullivan.

The other members of the boiler inspection staff are Sturgis C. Baxter, James D. DeShazo, Everett D. Dyer, David A. Dyer, Charles Ferguson, John H. Kazar, John McGrath and Freeman H. Sanborn.

Chief Boiler Inspector of the State, Joseph H. McNeill, and his assistant, Charles Ferguson, were at the scene of the explosion shortly after the accident for the purpose of finding the cause of the explosion and of reporting to the Governor, so that further necessary laws in regard to boiler inspection may be enacted. As yet no State inspectors have made any statement.

Failures of Steam Pipes.

Failures of steam pipes are caused by poor design, carelessness or neglect, and seldom by weakness due to the pipe having been originally too thin. The majority of failures are traceable to lack of provision for expansion and contraction, and to the movement occasioned by the vibration of the engine. The other principal causes are lack of suitable means for drawing off the water of condensation, faulty workmanship and defects that have developed while the piep has been in use.

Steam piping can be so designed that ordinary carelessness or foaming of the boilers will not cause an accident. Lack of sufficient head room, however, often creates considerable difficulty in laying out a steam piping system, and occasionally prevents the designer from adopting the best arrangement.

A VILLAGE ELECTRIC LIGHTING STATION

By W. H. Wakeman.

The following explanation of machinery used in a certain village for operating street lamps that are scattered for miles over country roads, should prove interesting to those who follow the course of events in such matters, also to students of electric lighting problems as presented in every-day practice.

Fig. 1 is a plan of the station as it was run for several years, in which 2 is a direct-connected high-speed engine, generating an alternating-current that is delivered directly to the street lamps.

A small dynamo used as an exciter is driven by a belt from the crank shaft. This unit is not large enough to carry the maximum load.

A medium speed, long stroke, simple engine is shown at 3. It is belted to a shaft in the usual way, that is, supported on floor stands, about 3 feet above the floor. There are two pulleys on this shaft, so arranged that either one of them may be stopped at pleasure by means of a clutch, carried by a quill. Each pulley carries a belt that drives an alternating-current dynamo, as shown at 4 and 5. This engine is not large enough to carry the full load, and while both units when run together are more than sufficient for the purpose, to operate the plant in this way has not proven economical and satisfactory, hence a change was made.

Fig. 2 is a plan of the new arrangement in which the high-speed engine 2 is retained, but the medium-speed, long-stroke engine has disappeared, and in its place there is a cross-compound engine, but it stands at right angles to the former's posi-

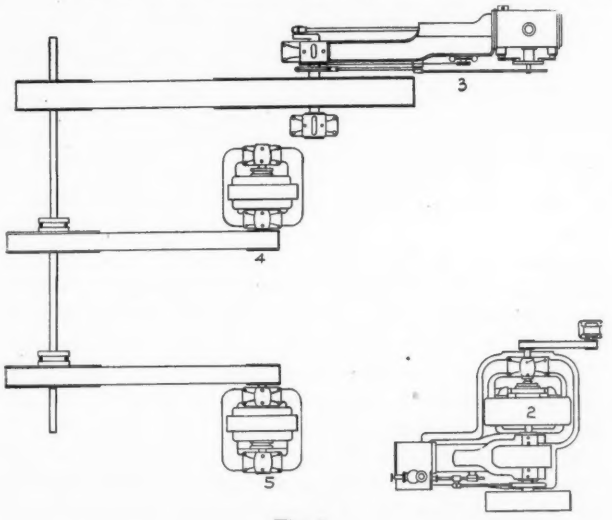


Fig. 1

tion. The crank shaft of this engine carries a generator that delivers a direct-current at 550 volts to a large motor 4 that is belted to the shaft as the engine was, from which is driven the alternating-current dynamos 5 and 6, as before.

The cross-compound engine and the motor are large enough to drive the dynamos at full capacity, and although such an arrangement of machines is not the most economical that could be devised, it is a very good plan when all conditions are carefully taken into consideration.

The idea of generating a direct-current to drive a large motor, which in turn drives two alternating-dynamos, seems absurd on the face of it, as it appears to be more scientific to

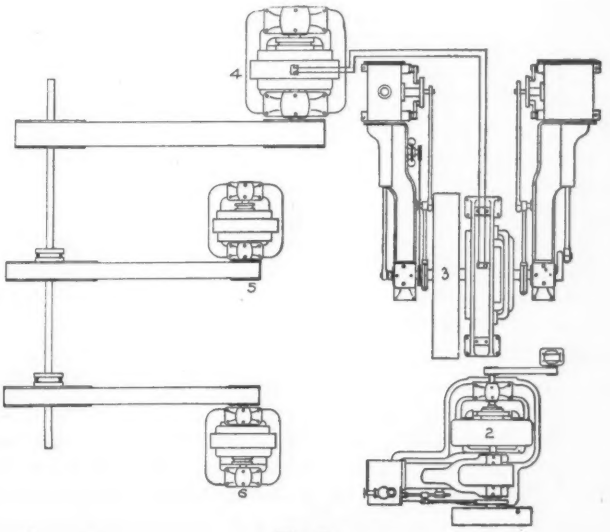


Fig. 2

belt the engine directly to the shaft, but the corporation that owns this station operates many miles of street railways on which direct-current is used to transmit power, hence in case the cross-compound engine fails from any cause and the high-speed engine is not large enough to carry the load required at that time, current from another and larger station several miles distant can at once be turned on to run the motor and keep the plant in operation.

This plan is also available in case the boiler plant fails from any cause, and it is thus possible to operate the entire plant with but one man on the premises: to turn on current from the other station, regulate voltage and keep the bearings lubricated.

Inasmuch as a direct-current is generated, and an alternating-current delivered to the lamps, it is plain that the motor 4 and the dynamos 5 and 6 constitute a rotary transformer, which transforms a direct-current at 550 volts and an amperage that varies with the load, into an alternating-current with a voltage due to the load and a constant amperage of about 10.

Probably this station would not have been fitted up in this way if all the machinery had to be bought new, but the necessity of utilizing apparatus already on hand was a prominent factor in determining the plan to be adopted, and when all points are taken into consideration the arrangement is very good.

The area of steam pipes should be amply large for their duty. A large steam pipe is a good fault, especially when it supplies engines not using regular quantities of steam, as it then acts as a reservoir. With very high pressure or with a regular flow of steam, too large a pipe is not advisable, as it may serve as a lodging place for water.

CALCULATIONS OF BOILER STAYS

Various Rules which are Generally Needed in Engineers' Examinations

By Chas. J. Mason.

Every engineer knows that flat surfaces in steam boilers must be braced or stayed in order that such surfaces may be able to withstand the force due to the pressure of steam which acts against them. The tendency of the active force within a boiler under steam is to cause the confining plates of metal to assume the shape of a sphere. Those plates in a boiler which are already bent or formed somewhat in the form of a sphere—such as the heads of the steam drums in water-tube boilers—require no bracing, for they are already in the form in which the force in the boiler would tend to make them.

It is necessary in certain types of boilers that there be flat surfaces, and so these surfaces must be braced or supported, against the force which tends to bend them outward. There are different methods of staying a boiler, but it is the intention of this article to deal only with the arithmetical calculations pertaining to stays and stayed surfaces. To this end, the rules and formulas which are here given are grouped in such a way that the reader may pick out and apply that which may suit any particular problem he is dealing with. By making a careful study of the group, the reader will probably see why the various factors are placed as they are, for it is simply a case of transposition of terms, and it should not be very difficult to understand how to handle them.

The total force acting against a flat surface in a boiler is found by multiplying the pressure per square inch by the area in square inches of the surface. Suppose, for example, we consider a flat surface which is 12 inches by 12 inches or one square foot, which contains 144 square inches. Now, if the pressure per square inch is 100 pounds, the total pressure on the entire surface we are considering will be $144 \times 100 = 14{,}400$ pounds. If there were a certain number of stays secured to the surface and equally spaced, each stay would bear an equal part of the total force due to the pressure. It is a matter of calculation as to how many stays should be placed in any given boiler, and also what size such stays should be in order to properly carry their load.

In stationary boiler works, 6,000 pounds per square inch section are allowed on boiler stays; this means, that if a stay is one square inch in section, it must not be subjected to more than 6,000 pounds stress. A stay which is 1⅛ inches in diameter, contains approximately 1 square inch sectional area and would be allowed 6,000 pounds total stress. As the breaking stress per square inch section of iron is anywhere from 45,000 pounds to 50,000 pounds, it will be seen that the factor of safety employed in stay calculations is about 8. So that a stay could endure about eight times the amount of stress required of it before breaking.

The number of stays in a given surface (which also determines at what distance apart they should be) depends upon certain conditions, among which is the diameter of stay to be used. If a certain diameter is made choice of, then the number of stays and spacing must conform to the chosen diameter. From this, it will be understood, a little plotting is necessary at the outset in laying out the size and number of stays for a given boiler. The grouped formulas will assist in an understanding of this matter by showing almost at a glance what way to proceed.

First we will consider through stays, stay rods from end to end, of boiler heads that are at right angles to the surfaces which they support. The size of a stay considered in calculations is that of the smallest diameter, usually at the bottom of the thread, if the stays are screwed at the ends; in any case, the weakest part. The distance from centre to centre of stays, squared, gives the number of square inches of surface held or supported by each stay. For example, suppose stays are spaced 6 inches apart from centre to centre, measuring in horizontal and vertical directions as shown in Fig. 1, in which case the area held by each stay will be $6 \times 6 = 36$ square inches. If the area held by one stay be given, the distance the stays are apart can be found by extracting the square root of the number representing the area. If the reader does not understand how to find the square root of a number in the regular way, he can refer to a table of square roots. But in

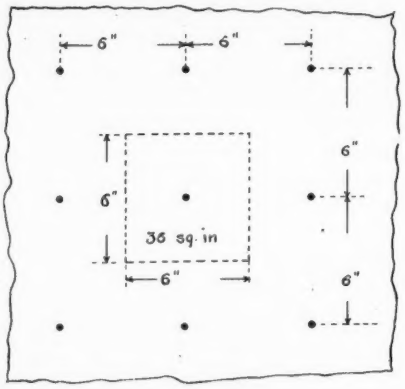


Fig. 1.

boiler stay problems this will hardly be necessary, because of the comparatively small numbers obtained, the square root of which can be seen almost at a glance.

The first rule is to find the diameter of stays, when the area held by one stay, the pressure per square inch, and the allowable tensile stress are given.

1. Multiply the area held by one stay (expressed in square inches) by the pressure per square inch in pounds, and divide the product by the allowable tensile stress per square inch section.

This expressed in formula, appears thus:

$$\frac{A\ p}{t} = a \qquad (1)$$

in which A = area in square inches held by one stay
p = pressure in pounds per square inch
t = tensile stress allowed per square inch section. This is given as 6,000 pounds
a = area in square inches of stay

from which can be found the diameter by dividing the area so found by .7854 and extracting the square root of the quotient; or

$$\sqrt{\text{area} \div .7854} = \text{diameter.}$$

The second rule is to find the distance apart the stays should be when the diameter (from which can be found the area) of stay is given, also the allowable tensile stress per square inch and the pressure in pounds per square inch.

2. Multiply the diameter of the stay by itself and that product by the constant .7854 to find the area of the stay. Next, multiply the area of the stay by the allowable tensile stress, and divide the product by the pressure in pounds per square inch. Expressed in formula:

$$\frac{a\ t}{p} = A \qquad (2)$$

and

$\sqrt{A}$ = distance between stays from centre to centre.

The third rule is to find the allowable tensile stress, when the area of the stayed part supported by one stay, the pressure per square inch and the area of one stay are given. This rule would not be called for in practice, and it is given here only to complete the group and show the existing relation between the various formulas.

3. Multiply the area of part supported by one stay by the pressure per square inch, and divide the product by the area of one stay.

In formula it is:

$$\frac{A\ p}{a} = t. \qquad (3)$$

The fourth rule in the group is to find the pressure per square inch, when the area of one stay, allowable tensile stress, and area supported by one stay, are given.

4. Multiply the area of one stay by the allowable tensile stress, and divide the product by the area held by one stay. Or, in formula:

$$\frac{a\ t}{A} = p \qquad (4)$$

One example to which rule (4) will be applied, will serve to illustrate the method and application of the formula, and the interested reader may apply the three other formulas to the same example for practice.

The stays in a boiler are 1¼" in diameter at the bottom of the threaded part, and are 10 inches apart from centre to centre; the allowable tensile stress is 6,000 pounds per square inch section of stay. What pressure per square inch would be allowed? The area of one stay will be

$$(1\tfrac{1}{4})^2 \times .7854 = 1.2272 \text{ square inches}$$

The area of part supported by one stay will be $10 \times 10 = 100$ square inches. Applying rule or formula (4), we have the statement:

$$\frac{\overset{(a)}{1.2272} \times \overset{(t)}{6000}}{\underset{(A)}{100}} = \underset{(p)}{73.63} \text{ lb. per sq. in. allowed.}$$

Strictly speaking, the area of the stayed surface occupied by the stay itself, should be deducted, but it is seldom allowed for; and by neglecting it, the factor of safety is increased, as the neglect is on the safe side, as a little thought will show.

Sometimes diagonal stays are used instead of the kind we have been considering, and so our second group of formulas will relate to diagonal stays. The diagram, Fig. 2, will assist to a better understanding of the use of the formulas, l being the length in inches of stay, and d = distance in inches from head, to point of attachment of stay to the shell. As much of the explanatory matter in the preceding part of this article may be applied to what follows, we will immediately take up the rules and formulas in the group we are to deal with.

5. Rule (5) is to find the area of a diagonal stay (from which the diameter of stay can be determined); having given the length of stay, l, the distance of point of attachment of the stay to the shell, from the head, and the area of an end to end stay that would be required, as found in the just group of formulas considered.

Multiply the area of direct stay required, by the length of diagonal stay l, and divide the product by the distance of point of attachment to shell from the head (see sketch) d. This quotient will be the area of the diagonal stay, from which the diameter may be found as before explained. In formula it is like this:

$$a_2 = \frac{a \times l}{d} \qquad (5)$$

and

$\sqrt{a_2 \div .7854}$ = the diameter of required diagonal stay.

The values of the letters used have been before given, except that of a_2, which stands for the area of the diagonal stay.

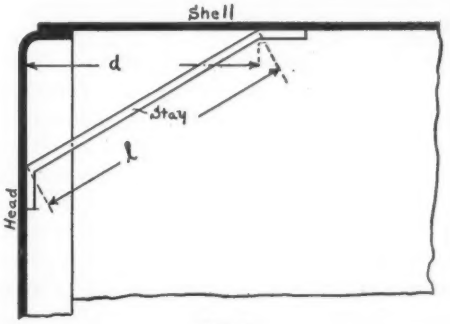


Fig. 2.

6. Rule 6 is to find the length of a diagonal stay, having given the area of diagonal stay, the distance d, and the area of end to end stay.

Multiply the area of diagonal stay by distance d, and divide by the area of end to end stay which would be required. The quotient will be the required length of diagonal stay. Expressed in formula:

$$\frac{a_2\ d}{a} = l \qquad (6)$$

7. Rule 7 will give the relative area of an end to end stay, having given the area of diagonal stay, the distance d, and the length l.

Multiply the area of diagonal stay by the distance d, and divide the product by the length of the diagonal stay. In formula:

$$\frac{a_2\ d}{l} = a \qquad (7)$$

from which can be found the diameter.

Rule 4, and the last of this group, will find d, having given, area of end to end stay, length of diagonal stay, and area of diagonal stay. Thus, multiply the area of end to end stay by length of diagonal stay, and divide the product by the area of the diagonal stay. In formula:

$$\frac{a\ l}{a_2} = d \qquad (8)$$

Now, let the interested reader choose an example as we have done before, and apply these formulas to the example, and thus see how the operation occurs. In this way the application of the formulas will be the better understood and remembered. If the scheme of the grouping of the formulas is once understood and tried, it would be difficult to *forget* them rather than difficult to remember them.

CLEANING OF WATER-TUBE BOILERS

By Wm. Kavanagh.

In the care and management of water-tube steam boilers, there are many things to consider in order to maintain this type of boiler in a satisfactory and economical working condition, as this type is most difficult to keep clean and free from scale. In some types of water-tube boilers doors are located in the walls which run parallel with the tubes, for the purpose of blowing any ashes and dust that may have accumulated on those tubes during the run; others have holes located between the tubes in each head for the same purpose.

When the blowing holes are located in the heads, a piece of pipe having an outside diameter sufficiently small to enter those holes must be employed. The pipe is connected to a hose and entered in each hole its entire length, the steam or compressed air being turned on during this operation. The piece of pipe varies in length according to the length of the boiler, and as there is usually more room in the front of the boilers than in the rear, the tubes are blown from the front, as it allows the longest piece of pipe to be used. It generally requires two men to do the blowing, one man entering and withdrawing the pipe, while the other man turns the steam off and on. In this way all the tubes are blown both front and rear.

In the type of boiler having the blowing or cleaning doors situated along the side wall, a steam blower is used to dislodge the dust and ashes; each door is opened in turn and the blower is passed between the tubes. Sometimes the blower pipe is bent in the shape of the letter L, so as to permit of turning it up or down between the tubes. This shaped pipe allows the tubes to be blown along the side as well as on the top.

It pays to blow or clean the tubes at least once each week, and where soft coal is used the tubes should be blown at least twice each week.

Almost all water-tube boilers are equipped with cleaning doors situated in the rear, sides and above the tubes. The door above the tubes permits of inspection, the steam drum, tubes, deflecting arches and the condition of the side walls can be seen, and repairs promptly made when necessary. It will be understood that in this type of boiler, the heated gases are made to traverse the tubes and drum by means of deflecting arches, and should the brickwork of those arches become loose or leak, the steaming power of the boiler will diminish rapidly; hence, to keep those arches in repair and gas-tight is an important factor in the economical generation of steam.

In some types of water-tube boilers the heads are fitted with plugs or plates to correspond with the number of tubes composing the boiler; if the boiler is composed of one hundred tubes, there will be two hundred plugs or plates, and besides there will be hand-hole plates for the purpose of cleaning the water-leg of the heads and for entering the plugs and plates in position. In cleaning out the tubes of this type of boiler, either a hydraulic, steam or pneumatic tube cleaner should be used. Satisfactory results cannot be obtained from the use of a tube brush, as its use involves too much labor; besides, sufficient pressure to remove the scale cannot be obtained by such antique methods.

The first three or four rows of tubes over the fire are considered sufficient to open and clean, as the rapid circulation of the water set up in the tubes is depended upon to carry all deleterious and scale-making substances down to the lower tubes and water-legs of the heads, where it can be blown off at the proper time.

If the water-tube boiler is not attended to and properly cleaned, it will be considered one of the poorest steamers imaginable. In general, a water-tube boiler is a quicker steamer than the tubular boiler, but the tubular boiler has its advantages, namely, less labor and expenses for cleaning and repairs and a greater length of life.

Very few water-tube boilers have the feed-pipe entering the leg, modern practice being to feed this type of boiler in the drum; usually, the feed-pipe enters the front head and extends almost its entire length, the feed-pipe being perforated and open at the extreme end. In some cases the open end is connected to a vessel that acts as a mud-catcher, which prevents considerable dirt from being discharged on the shell of the drum or surface of the tubes. The drum-blow is connected to this vessel, and by a judicious use of this blow a considerable amount of undesirable matter can be prevented from lodging among the tubes or on the surface of the drum.

Drips from Steam Mains.

The drips from all steam mains should lead to a receiving tank, and the water be automatically pumped back to the boiler. If the drips lead from mains under different pressures, then the drips should be trapped. Sometimes the drips can be drained back by gravity into the boilers by a check valve at the boiler, but the receiving tank system is generally the better.

All condensed steam containing grease or oil should be kept separate and passed through a grease extractor or be filtered before being returned to the boilers.

ARITHMETIC FOR ENGINEERS

Useful Points about Multiplication and Factoring

By E. S. Hawkins.

Part II.

Probably the first thought of the reader in glancing at the above title will be a question something like this: "Don't he know that no one needs to be told that $2 \times 5 = 10$, or that $6 \times 7 = 42$?" It is not the purpose of this article to harp on the trite facts of arithmetic, but to point out some of those little details that make the difference between the work of the calculator and the efforts of the school boy to solve his simple "sum." The other day I talked with a figure fiend and asked him if he could tell me the product of 67,923 × 135,874. Almost before I had pronounced the last figure he said, "9,228,959,702." How did he do it? By having, in the first place, a head for figures and, in the second place, a great amount of training and practice. Not every one can do this; nor is it desirable that every one should do so. If, on the other hand, we all master some of the more useful rules and short cuts in plain old arithmetic, the effect will be seen in all the work that we have to do.

Where formerly it was necessary to stop and hunt a pencil to figure up a simple problem, perhaps the total of purchases at the hardware store, we can turn the figures over in the head before the clerk has had time to foot up the items on the cash check. On the street car, it may be, the busy man turns over in his mind the dimensions of his boiler setting, for instance, and, by his knowledge of proportion, determines whether or not the grate surface is what it should be for the increased amount of work that the boiler is being called on to do. A thousand and one little things will be easier and, in fact, there is hardly anything about the plant that will not have a different look to the man who can size up dimensions and proportions in his head, compare one with the other, and see if they are right.

Multiplication is really nothing more than a short process of adding the same number to itself a given number of times, and division is the process of subtracting the same number several times. The number that is to be added is the multiplicand, and the quantity or figure representing the number of times it is to be added is the multiplier. Similarly, the number that is to be subtracted is the divisor, and the quantity from which it is subtracted several times is the dividend, while the number of subtractions is the quotient. The result of the process of multiplication is the product. It will be seen that, just as addition and subtraction are the opposite of each other, so is multiplication the opposite of division. In multiplying two quantities it makes no difference which of them is taken as the multiplier and which as the multiplicand, but it is evident that the name of the product will be the same as that of the multiplicand; thus we may have 10 bearings and we may have $2 \times 10 = 20$ bearings, but the result will be the same if we say $10 \times 2 = 20$ bearings.

No doubt, almost every one remembers the horrors of "learning the multiplication table", but it would seem that all the work was unnecessary or, at least, could have been made easier by the use of Table I, which was first made out by Pythagoras. Either the horizontal row of figures at the top of the table or the left-hand column, may be taken as multipliers, while the set of figures not so selected will be the multiplicand, and the product of the two will be found in the body of the table opposite the intersection of the horizontal and vertical lines drawn from the two figures selected. Taking, for instance, the multiplier 7 in the left-hand column and following over to the right until under the figure 8 in the horizontal row at the top, the result is $56 = 7 \times 8$. This is the table as ordinarily employed in this country, and by practicing with the different figures for a short time it will be found second nature to recall the product of any two figures without any effort of the memory. It is said that the Chinese are more industrious at memorizing this table than the average American, for the reason that the men of the laundry commit to memory the products of all numbers up to $144 \times 144 = 20{,}736$. There are those in this country, however, known to carry a table of logarithms in the head, but all this is aside from the needs of the average engineer.

Table I.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

It is evident from the definitions that any number multiplied by 0 gives 0 as a product, and a number is unchanged when multiplied by 1. On the other hand, a number divided by 0 gives a quotient infinitely large, which is the same as saying that we can go on subtracting 0 from the number an indefinite number of times with no effect in reducing its value.

Factors.—For mental calculations it is necessary above all things to be familiar with factors, or the figures that multiplied together will give a certain number as the product: thus, $3 \times 4 \times 7 \times 5 = 420$, and the result will be the same no matter in what order the figures are taken. Knowing this fact, it is often possible to take the factors of a number in such order that the work of multiplying them together and by another number will be much simplified. In doing head work it is much simpler to multiply a large number by one of the factors of another number which is used as the multiplier and then multiply the product so found by each of the other factors of the multiplier in succession. With a little practice one of the numbers can be factored and the different multiplications performed in less time than it takes to tell it. As an example, suppose that it is required to multiply 5,873 by 25, first we take $5{,}873 \times 5 = 29{,}365$, and then take $29{,}365 \times 5 = 146{,}825$.

If a number is to be multiplied by another containing at the left a single figure with one or more ciphers to the right, it is only necessary to multiply by the single figure and place the given number of ciphers to the right of the result: thus, if 637 is to be multiplied by 300, we have $637 \times 3 = 1{,}911$, and,

adding the two ciphers, the final product is 191,000. In a similar way the product of two single figures with ciphers to the right of them is the product of the figures themselves with all the ciphers of the two added and written to the right of the result: thus, 400 × 7,000 = 4 × 7 = 28, and with the five ciphers the result is 2,800,000.

Almost any one can multiply two numbers together and, after so long a time, get the correct result; but the secret of the thing is in doing it in such a way that the other fellow couldn't get his answer first. In other words, be "Johnny on the spot." Suppose that 458 is to be multiplied by 6; this is all simple enough, but be sure when you set the figures down that you put them directly in line one under the other, so that when you are in the midst of the calculation it will not be necessary to stop and consider where a certain figure belongs. In doing the work one says: 6 times 8 are 48 (write 8, carry 4); 6 times 5 are 30 and 4 are 34 (write 4, carry 3), etc., to the end of the multiplication. In reality one should become so accustomed to handling the figures that it is not necessary to say anything more than each of the partial products as, 6 × 8 = 48. The writing and carrying are done, as it were, automatically by a secondary process of the mind that does not come to the surface to disturb the thought about the problem.

It is this facility in doing the work that is most valuable, for it enables the man working the problem to balance his results up with facts as he goes along, so that he can check the correctness of the work by positive knowledge and not be compelled to accept his addition because he *thinks* it is done without error. When he has finished the work his mind is as clear as a bell, and he knows that if his fingers had attempted to make a "slip of the pen" at any point of the process he would have detected it at once. It is this method of doing the work and only this that gives one the confidence to say that "the result is correct", instead of saying "I think I have the right answer." This may sound like talk, but it is the thing above all things that makes for "accuracy and usefulness in figures."

Where there is more than one figure in the multiplier the operation is the same as above, there being a partial product for each of the ***significant*** figures in the multiplier. Example:

```
  5,736
    743
  -----
  17208
 22944
40152
-------
4,261,848
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With ciphers in the multiplier, the work is as follows:

```
  34,256
   3,002
  ------
  68512
102768
--------
102,836,512
```

Here the partial product for the multiplier 3 is shifted to the left two places (the number of ciphers) and set down. This, of course, is the same position it would have had if there had been two intermediate partial products. To prove the multiplication of any two numbers, take the multiplicand for the multiplier and the product should be the same as at first. In lieu of this method, divide the product by the multiplier and the quotient should be the multiplicand, or divide by the multiplicand and the quotient should be the multiplier.

In multiplying large numbers, the correctness of the result may be tested by the principle that the number of figures in the product must be equal to the sum of the figures in the multiplier and multiplicand, or in some cases one figure less. If, for instance, there are three figures in the multiplicand and two in the multiplier, there should be either four or five figures in the product depending on the size of the left-hand figures in both multiplier and multiplicand. If the product of these two figures plus the amount carried from the previous place is 9 or less, the lesser number of figures will be found in the product. It is not worth while to use this principle except where the numbers multiplied are so large that there is a probability of making an error in setting down one of the partial products. This is, however, the most likely error with large numbers, and the principle forms the quickest means of detecting it.

In order to abbreviate as much as possible the work of multiplying two numbers, it is customary to take the smaller of the two for the multiplier unless the other contains a number of ciphers or like figures. In this way the number of partial products is reduced and, as already pointed out, there will be no such products where there are ciphers in the multiplier. In the case of like figures, the multiplication is performed only once, and the same partial product set down in its proper place. In case the numbers 11 or 12 appear in the multiplier, they are handled as single figures. Thus, in multiplying 84,742 by 11, one says:

```
                 84,742
                    116
                  -----
84,742           506452
    11          932162
-------         -------
932,162         9,828,072
```

11 times 2, 22 (write 2, carry 2); 2 and 11 times 4 are 46 (write 6, carry 4), etc. The process is the same where the numbers 11 or 12 form part of the multiplier only, as in the second example just given. In the case of the number 11 it is not necessary to do any multiplication at all, for, remembering that the process is only a short method of addition and that 11 times the number is only one more time than 10 times, we take the rule for multiplying by a number containing ciphers and set down one cipher to the right of the multiplicand and add to the number thus formed the original multiplicand. Thus, in the first example, one says: 2 (write 2 in the result); 2 and 4 are 6 (write 6, none to carry); 4 and 7 are 11 (write 1, carry 1); 1 and 7 are 8 and 4 are 12 (write 2, carry 1); 1 and 4 are 5 and 8 are 13 (write 3, carry 1); 1 and 8 are 9, and since there are no more units to the left, write 9 down in the result, thus completing the multiplication.

When a number which is almost an even multiple of 10 is the multiplier of another number, it will only be necessary to multiply the number by the amount which the multiplier given actually differs from the multiple of 10. As an example, suppose that 73,284 is to be multiplied by 9,998 (or 10,000 — 2), we write the four ciphers to the right of the number 73,284, and subtract from the number thus formed 2 × 73,284, thus:

```
732,840,000
    146,568
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732,693,432
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If any two or three figures of a multiplier form a multiple of another figure, the number of partial products is lessened by multiplying the partial product obtained with the first figure by the number of times it is contained in the multiple, and using the product thus found as the partial product for the multiple. Suppose, for instance, that 37,856 is to be multiplied by 48,546, in which it will be seen that 48 and 54 are both multiples of 6, the first containing it eight times and the other nine times. The work will be set down like this:

37,856
48,546

6..... 227136
54 = 6 × 9.....2044224
48 = 6 × 8....1817888

1,838,557,376

After becoming familiar with factors and multiples it is not necessary to write them down at the left.

If it is necessary to multiply any number by a multiple of 5, first multiply by 10, 100, 1,000, and divide by 2, 4, 8, etc., as the case may be. Thus, 5 times 17 = 170 ÷ 2 = 85; 25 × 17 = 1,700 ÷ 4 = 425; 125 × 17 = 17,000 ÷ 8 = 2,125, etc.

The Place for Pumps in Power Plants.

The location of the pumps in a power plant depends so largely upon the available space that in many cases the designer has little choice in the matter. Fortunately there is a wider latitude usually to be found in the location of equipment in a central station than in an installation for office building or hotel service, although in some of higher class isolated plants, a separate room is now provided for pumps, and there is no doubt that in many generating stations such a course would be advantageous.

In some cases the pumping equipment is installed in the engine room, and the principal advantage of so doing is the increased amount of attention the pumps receive from the engineering staff of the station. In general, the boiler room is not an ideal place for moving machinery, and although steam-driven feed and circulating pumps are rugged pieces of apparatus, there is no question that constant exposure to coal dust and dirt increases the rate of depreciation. Pumps and piping need care as well as anything else, and it is too much to expect the same attention in the boiler department as in the engine room.

The location of pumps in the engine room is open to the serious objection that such a course tends to crowd the equipment too closely together in plants where there are quite a number of pumps to be installed. Aside from boiler feed pumps, many plants are equipped with air and circulating pumps for condenser service, step-bearing turbine pumps, oil pumps, drainage, artesian well and fire pumps. The piping complications which these entail are an obstacle to free movement in the engine room and to clear supervision by the operating force. The most modern stations are conspicuous for the way in which similar equipment is co-ordinated in groups of operating units; ample clearance is allowed between units, and the grouping plan permits the widest flexibility in case of trouble. Thus, if all the boiler feed pumps are installed in a parallel row in a separate pump room the piping can readily be arranged to enable any pump to take up the load with minimum loss of time in case of trouble. If the pumps are scattered promiscuously around in odd corners, the pipe layout cannot be as simple, and hence as low in first cost, or the control so immediate and concentrated. Air and circulating pumps are almost always installed in the basement close by the condensers which they serve, but there is often the same opportunity for co-ordinating these in a group, with the feed and oil-pumps, step-bearing pumps, etc., that there is when the pumps are located in a separate compartment on the floor above. The pump installation ought to be well under the hands and eyes of the operating shift, in any case, and the plan of segregating this equipment in a group apart from the boiler and engine room apparatus is well worth bearing in mind in designing new plants. There is no reason why traditional practice in the location of pumps in the boiler room should not be departed from where it seems advisable.—*Engineering Record.*

ORIGINAL CORLISS ENGINE WORKS BURNED.

Compressed Air Explosions played Havoc with the Testing Shop of the American and British Mfg. Co., at Providence, R. I.

On the morning of December 5th fire played havoc with the testing shop of the Old Corliss Engine Works of the American and British Mfg. Co., located at Providence, R. I., causing a loss of about $100,000. The peculiarity of the fire, which is said to have been caused by a locomotive spark, was the explosion of three compressed air tanks. These tanks were situated on the roof of the burning building and were under high pressure. When the flames were at their height the compressed air became heated, and in expanding burst the tanks. One of the tanks was thrown across the adjoining railroad by the explosion, the second tank did damage in another direction, while the third could not be found.

The testing and assembling shop, where the fire occurred, had been in use for a half-century, and the timbers were more or less oil soaked, giving fuel for the flames. None of the other buildings of the plant suffered damage.

Among the machinery destroyed were four Diesel engines, five steam engines, a 250 kilowatt generator, several oil engines, three cranes and three auto-trucks.

Steam pipes should be of such size that the average velocity of flow does not exceed about 6,000 feet per minute. The area through valves should be somewhat in excess of that of the pipe, so as not to create loss of pressure due to friction. The steam pipe leading from a boiler may cause priming if made too large.

A rule for size of steam pipe to suit a boiler is that the area should not exceed the following: Area in square inches = $(0.25 \times \text{Grate area in square feet} + 0.01 \times \text{Heating Surface in square feet}) \times \sqrt{\frac{100}{\text{Pressure in pounds per square inch.}}}$

If wet steam is expected in a steam main, a steam separator on the steam pipe near the engine is recommended. A separator is a safeguard in every case, as it will prevent a possible accident to the engine from water, whether the water comes from priming, condensation, carelessness or otherwise, and it will also act as a steam reservoir.

The
Practical Engineer

DEVOTED TO THE ECONOMICAL GENERATION AND UTILIZATION OF POWER

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L. L. RICE

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Lap Seam Boilers and Boiler Explosions.

The recent boiler explosion at Lynn, Mass., an account of which will be found elsewhere in this issue, has again called the attention of the engineering world to the use of the lap-seam boiler and the method of inspecting boilers in general.

Not since the explosion of a lap-seam boiler at Brockton, Mass., in March, 1905, has an explosion created as much comment as this one, and while fortunately no lives were lost on account of the early hour of the explosion, the Brockton disaster would have been repeated had it occurred one hour later.

Massachusetts is generally looked up to by its neighboring States as having the most efficient license laws and the most carefully-laid plans for the inspection of boilers, so that it seems to be the irony of fate that within the past two years two disastrous explosions should have taken place there despite the care and attention given to the methods of preventing them.

At the present time boilers are either inspected by public inspectors or by insurance companies, and the boilers insured by these latter companies do not come under State or city inspection. However, insurance companies work together with State inspectors as a general thing, and the insurance companies' inspectors are registered with the State or local departments and the owners of the boilers are notified through the State department, in Massachusetts, of the pressure allowed and the other findings of the company's inspectors.

There is a general sentiment prevailing, however, that the State department should have supervision over all boilers within its jurisdiction, regardless of whether the boiler insurance company inspects a boiler or not. At the present time if an insurance company sees fit to insure a boiler, it is taken out of the hands of the State inspectors and they have no authority to prohibit or condemn its use. While it is not to be supposed that an insurance company would insure a boiler if the least doubt existed as to its safety, yet at the same time there should be some one who can be held accountable by law for the strict observance of the boiler inspection laws, so that if a boiler explodes the proper person or persons could be held accountable.

We believe and know it to be a fact, from our own experience and observation and the many letters which we have received from time to time, that the inspectors of insurance companies are the most faithful of men, and when they pass a boiler it is with a firm conviction in their own minds that the boiler is perfectly safe to run. This is also true about many public inspectors who have received their positions by merit.

But the most unjust criticism by the general public in the case of a boiler explosion, usually comes upon the engineer, especially if the boiler has been inspected. If the engineer is not killed by the disaster, he is often treated as a criminal, and in many cases his reputation is ruined. We do not believe there is an engineer who would run a boiler if he knew it to be unsafe, as certainly he values his life as dearly as any person. While there are cases, of course, where negligence is the cause of boiler explosions, probably 95 per cent. of all explosions are due to some defect in the boiler which is either overlooked or which cannot be detected upon inspection. And certainly the engineer cannot be blamed for them!

Of all the types of boilers which are in bad repute in this respect the lap-seam boiler is the worst, as it is impossible for the inspector to discover a crack in the seam if it occurs under-

neath the seam, as in this case it is invisible both to inside and outside inspection. The continuous breathing of the boiler causes this crack to become larger until the cross section of the retaining metal is reduced to the danger point.

If, therefore, the lap-seam boiler is of such construction that it cannot be properly inspected, then why do the insurance companies and State inspectors pass such a boiler? A careful man these days will not buy a piece of property if the title is not insured; neither would a careful manufacturer buy a lap-seam boiler if he knew it could not be insured. If the State inspectors will refuse to pass a lap-seam boiler, then the boiler could not be used and the purchaser would be compelled to buy another type of boiler.

So far as the engineer is concerned it makes no difference to him whether the lap-seam boiler is prohibited from use or not, except in so far as it will remove a piece of apparatus which is incapable of complete inspection; and so far as boiler manufacturers are concerned, they can just as easily make boilers with butt-strap joints and they would do so if they were compelled to.

Whenever a lap-seam boiler bursts and the cry goes up that it is due to that type of boiler, it at once gives the impression that something must be wrong with our inspection laws. Boilers do not have to burst and they can be made so that they will not burst. If they do burst after inspection, then it is either the fault of the insurance companies or the State departments for passing the boiler—not the inspectors themselves, but the authorities that allow it.

Something should be done to eliminate this element of unsafety around the power plant, and it will not be many years, in some States at least, before laws will be drafted so as to prevent boiler explosions and the horrors and disaster that usually attend them.

Beginning of the Alcohol Age.

With the beginning of the year 1907, the law removing the tax on denatured alcohol prepared for use in the arts, industries and sciences, will go into effect. The actual working of this law has aroused much interest, but many misleading ideas have been put forth regarding it. For example, it has been stated that since alcohol can be made from numerous by-products of the soil, as well as from grain and potatoes, every farmer will be able to set up a distilling apparatus in his own yard, with the presumable result that he will immediately secure a new and profitable source of income, or, connected with every alcohol engine, there could be a still erected from which the products for the internal combustion can be obtained.

As a matter of fact, the information sent out by the Internal Revenue branch of the Treasury Department, shows that nothing of the kind is feasible under the existing statute. Every person who seeks to turn out industrial alcohol is required to have a bonded warehouse for the storage of the fluid when it is distilled, and another warehouse where the operation of "denaturing" or putting in ingredients to make the alcohol undrinkable shall be carried on. Each step in the process must be watched and supervised by Federal employees to make sure that the law is not evaded.

In Germany, where there are over 6,000 farm distilleries, many of them being very small, the stills are made in a certain way which includes a tank which can be locked with a Government lock and sealed with a Government seal, after which the still is ready for use. When the distillation is completed, the Government is notified and an inspector comes and removes the seal and measures the contents of the tank and collects the revenue. If the alcohol is to be denatured, it can be done in the presence of the inspector, when the amount of tax will be returned.

In Germany alcohol is made mostly from potatoes, and the wholesale price averages about 26 cents a wine gallon of 190 degrees strength. The average yield of potatoes per bushel was around 225 bushels per acre. The extent of this industry in Germany is shown by the fact that 91,000,000 bushels of potatoes were consumed in the manufacture of alcohol, the product being one gallon of alcohol to 1.26 bushels of potatoes.

Alcohol is used abroad for heat, light and power, and its use is fast increasing, while as yet this country knows very little about its application. But with the beginning of 1907 the alcohol age in this country may be said to have begun its reign. If other countries can run their engines, light their buildings and otherwise utilize this clean and colorless liquid, then surely this country will not be far behind when the preliminary arrangements and experiments with this class of fuel shall have been completed.

Utilization of Lignite or Sub-Bituminous Coal in California.

The principal feature of interest connected with the production of coal in California has been the apparently successful efforts to utilize the lignite or sub-bituminous coals produced in the State in the manufacture of briquettes, says E. W. Parker, of the U. S. Geological Survey. During 1905 there were four of these plants in operation. One, at Stockton, was operated by the San Francisco and San Joaquin Coal Company, which used the lignite or sub-bituminous coal produced at the Tesla mine, owned by the same company. Another plant constructed in Oakland by the Western Fuel Company upon designs prepared by Mr. Robert Schorr, of San Francisco, was put in operation during the latter part of the year. The third plant, a small one, owned by the Ajax Coal Company, of San Francisco, was in operation during most of the year, and the fourth, which was built at Antioch, was not completed until the latter part of the year.

All of these plants were constructed for the purpose of using the California lignites or sub-bituminous coals, sometimes with and sometimes without a mixture of "Wellington" and other bituminous screenings obtained at the coal yards, and using asphaltic pitch as a binder. This pitch is obtained as a residue from California crude petroleum which, when properly distilled, yields a pitch possessing excellent binding qualities.

The briquettes make a good domestic fuel, and are also much better adapted for use under boilers than the raw fuel from which they are made. The use of them or of the raw coals in California, however, has been much less than it would have been because of the greatly increased production of petroleum, and of its use for steam-raising purposes in both locomotive and stationary boilers. As a result of this the production of coal and lignite in California has shown a decreasing tendency during the last five years.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Friction on Valve Stems will not Cure all Pumps from Short-Stroking.

EDITOR THE PRACTICAL ENGINEER:

In the December issue M. H. H. suggests a remedy for a simpler pump short-stroking which is very good, as far as the Deane pump is concerned or any other pump in which the valve stem is not fastened directly to the piston operating the main valve. Giving friction to the valve stem of a Knowles horizontal pump, by screwing up on the packing, would have a tendency to make the pump stop when running slow. It would be better to use the device provided by the makers; that is, increase the tension on the spring washer on the suspension pin of rocker.

Fall River, Mass. W. N.

Remedy for Dean Pump Trouble.

EDITOR THE PRACTICAL ENGINEER:

Under the title of "Cause of Cure for Mr. Arnold's Pump Trouble", in the December issue, I see that M. H. H., of Fall River, Mass., gives some experience that he has had in running condensing pumps, and refers to the Deane condensing pump. As he says he would like to hear from other engineers, I would say that I have been running two Deane condensing pumps alternately and part of the time for nearly twenty-one years, depending upon the water supply which the town demanded, and I have experienced the same trouble that is referred to.

I would often have to screw up the stuffing-box gland on the valve and would often have to put in new packing, and the rod would wear down badly where it went through the packing, so that I would have to put in new rods. To avoid having to screw so hard on the packing on the steam end of the rod, I drilled out the hole in the support at the water end of the rod and tapped it, and screwed in a half-inch pipe coupling, put in a reducer for packing shoulder and another reducer for gland, and put in packing and screwed it up. Thus I had friction on that end of the rod, and I did not have to screw the other end so hard.

I think that Mr. Arnold and Mr. M. H. H. will observe that the pump usually stopped when the rod was to go one direction and not very often when the pump was on the other stroke, which was due to the difference in pressure on the ends of the valve rod that moved the auxiliary valve; and that pressure being equal to the surface end of the rod, the fraction of a square inch, more or less, was sufficient to shove the rod and valve ahead, thus admitting steam to the piston that moved the main valve.

Mr. B. U. Potter, expert mechanic, with the Deane Steam Pump Co., has introduced a novel plan to prevent that pressure on the end of the rods of pumps. He had a stuffing box put on the other end of steam chamber and the valve rod run through and out that end of the steam chamber. By drilling a hole in the end of the present valve rod and tapping it, a piece of the same size rod can be turned smaller at the end and a thread cut on it and a slot sawed in the other end of it, so that it can be screwed in with a screw-driver. Have it long enough to come through the packing on the outside of the pump and it will do away with the trouble of the valve jumping ahead and stopping the pump.

One year ago last June we had the pump steam-cylinders bored out for the first time since they had been put in here, and we had the valve-rod arranged as described above. I have had no trouble with the pump stopping since, and I can run the rod with packing screwed up with fingers and the packing will last a year, the rod being scarcely worn down any. If the valve-rod is ½-inch diameter, the area of the end of the rod will be 0.2 of a square inch, and if the steam pressure was 60 pounds, the pressure on the rod tending to push the auxiliary valve rod in one direction would be about 12 pounds; this must be held by the friction of the valve on its seat and the friction of the packing, all of which would be avoided by having the rod run out the other end of the pump.

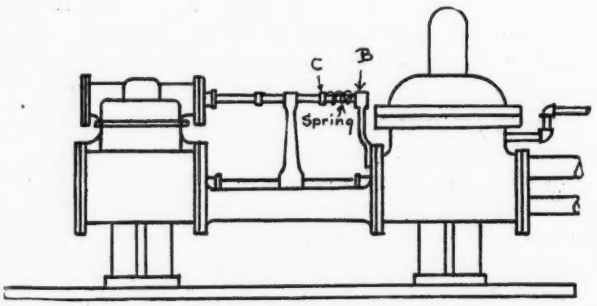
Middleboro, Mass. A. R. G.

Coiled Spring Will Cure Pump Trouble.

EDITOR THE PRACTICAL ENGINEER:

I notice with interest the article, "Pump Troubles", in the September number of THE PRACTICAL ENGINEER, written by L. L. Arnold. I also see another article in the November number, by "J. M.", giving his idea of the proper cure for the trouble.

I have had these kinds of troubles, too, and have applied a sure cure for short-stroking in this class of pump. Now, to begin with, L. L. A. asks what causes the "freaky" actions of his pump. In answering this it might be well to look for



Coiled Spring Cured Pump Trouble

the cause of the trouble in this case, as in any other: the trouble in this case arises from an unequal pressure which is caused by the steam pressure within the chest acting on the area of the valve stem. If the valve stem extended clear through the chest into the atmosphere with a stuffing box and equal area, there would be a balancing of the forces, occasioned by the steam pressure within the chest. Under this condition the valve stem would readily stay in any position it might be placed in by the tappet arm.

The leather washers cured the trouble for a time, at least, until they became hard from constant hammering by the tappet arm. The reason the washers stopped the trouble arose from the fact that leather is, to some extent, elastic. This fact allowed the tappet arm to place the valve stem in the correct position and start out on the return stroke without jarring the stem (due to the elastic cushioning effect of the newly-applied leather washers), thus preventing the steam pressure within the chest from acting on the area of the stem, causing the collar on the valve stem to follow out with the tappet arm, resulting in a short return stroke.

J. M.'s idea is to keep his stuffing box so full of hard packing and screwed up so tight that the steam pressure acting on the area of the valve stem cannot move the stem from any position it may be placed in by the tappet arm. I will admit that J. M.'s idea will stop the pump from short-stroking all right, but as for being the right thing to do I don't agree with him.

My cure for this class of trouble is the simple introduction of a coiled spring between the guide bracket B and the collar C. The spring is given sufficient tension to counterbalance the action of the steam acting on the area of the valve stem. The action of the steam is to force the valve stem out of the chest, while the action of the spring is to force it in again. In this manner the forces are neutralized, the valve stem tending to stay in any position it may be placed by the tappet arm. Try the idea and be convinced!

St. Louis, Mo. G. S. N.

Overhaul the Steam Chest if the Pump Short-Strokes.

EDITOR THE PRACTICAL ENGINEER:

After reading L. L. Arnold's and J. M.'s letters relating to their pump troubles, I thought that my little experience, that I once had with a Knowles vertical air pump, might help them out. The pump had two valves, one a small auxiliary D-slide valve which controlled the supply of steam to operate a chest piston, which in turn operated another slide valve that controlled the steam supply to the cylinder. The small valve was operated by a rod from the walking beam of the pump and the usual method of tappets on the valve stem. When the stem was about at half-stroke it would shoot out the full length of its stroke and short-stroke the pump.

It finally got so bad that I took the steam chest cover off and the valve out, and noticed then that the valve seat was cut between the exhaust port and the steam port; so I took off the steam chest and had the valve seat planed off and a new slide valve made, as the old one was then too small. This stopped the short-stroking, but the pump kept stopping intermittently just the same, and I was told by others that it had acted that way ever since it was installed.

So I wrote to the Knowles Pump Co. and they advised putting on a new steam end altogether, but as that was going to cost too much, I then consulted the Warren Pump Co., and, after looking over the pump, they advised that a new chest piston be put in, as it was discovered when we took the covers off that the chest cylinder was worn out or round and the chest piston was cracked. So when I saw the condition of things I had two small snap rings put on each end of the new chest piston to make it steam tight and take up wear of the chest cylinder, which, of course, had to be rebored. When this was done the pump started off nicely and has given no trouble since.

I think that the leather washers and hard packing on valve stem are only makeshifts, for I tried tight packing and also a coil spring in front of the outside tappet, but the packing would wear slack and the spring broke; then the trouble would start again, so I think if they will overhaul the interior of the steam chest of their pumps that they will find the trouble is there.

I have learned considerable from the letters and articles in THE PRACTICAL ENGINEER, and much of it things that are not found in text-books. Mr. C. J. Mason's answers to engineers' question in the November issue are especially good, so also is Mr. W. Kavanagh's article on "Care and Management of Boilers"; they are both clear and practical.

Fall River, Mass. J. R.

The Economical Engineer.

EDITOR THE PRACTICAL ENGINEER:

The engineer having bought a half-dozen joints of stove pipe to fix up his engine room stove for the winter, and having some other purchases to carry, he wanted to tie all the joints in one bunch, but having only a limited amount of wire, he was at a loss to know how to place them so that the least amount of wire would be required.

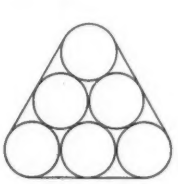


Fig. 1.

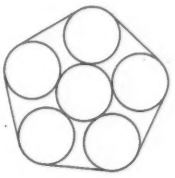


Fig. 2.

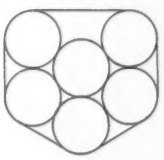


Fig. 3.

He first placed them in the well-known triangular form, as shown in Fig. 1; then he placed them as shown in Fig. 2, by putting one in the centre and the other five around it at equal distances from each other, all touching the centre one; then he placed them as shown in Fig. 3, by placing one in the centre and the other five partly around it, the five outside ones touching each other. Which of the three arrangements requires the least wire to go around the pipes?

Cambridge, Ohio. SCOTT.

Simple Rules for Finding the Heating Surface and Water Capacity of a Horizontal Return Tubular Boiler.

EDITOR THE PRACTICAL ENGINEER:

As in none of the books which I have can I find good, practical rules for finding the heating surface and water capacity of horizontal return tubular boilers, I am sending several which may interest your readers.

To find the heating surface of a return tubular boiler, square the diameter of boiler in inches and multiply by .7854, which gives the area of one head. Square the diameter of one tube and multiply by .7854 and multiply by the number of tubes; this will give the cross-sectional area of tubes. Take two-thirds the area of the head and subtract from it the cross sectional area of the tubes; multiply this result by 2 and the heating

surface of both ends is obtained. Now multiply the diameter of a tube by 3.1416 and then by the length of tube in inches, and this result by the number of tubes; this gives the heating surface of the tubes. To get the heating surface of the shell, multiply the diameter of boiler in inches by 3.1416 and by the length in inches, and take two-thirds of this for the heating surface of shell. Now add heating surface of shell, tubes and heads and divide by 144. The quotient will be the number of square feet of heating surface in the boiler.

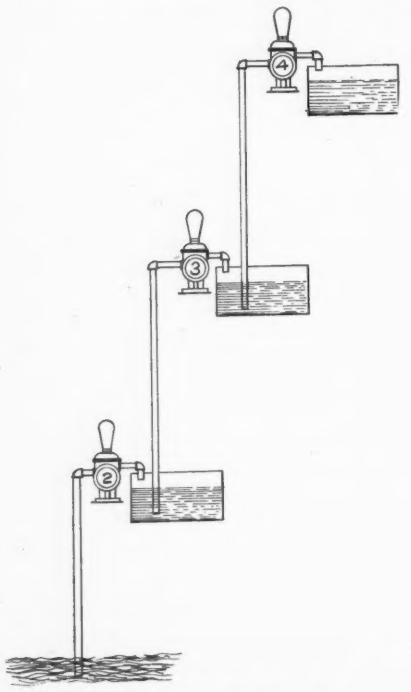
To find the water capacity, square the diameter of boiler in inches and multiply by .7854; multiply the product by length of boiler in inches and the result will give the number of cubic inches the boiler would hold if full and it had no tubes. Square the diameter of one tube and multiply by .7854, by the length of tube in inches and by the number of tubes; this will give the space the tubes take up. Now take two-thirds the capacity of the whole boiler and subtract the space the tubes take up, and the result will give the number of cubic inches of water capacity of the boiler. Divide this result by 231 and the number of gallons of water capacity of the boiler will be obtained.

Groton, Mass. CHAS. J. WRIGHT.

Method for Lifting Water 60 Feet.

EDITOR THE PRACTICAL ENGINEER:

In the accompanying illustration, 2 is a pump that is drawing water from a river, lifting it 20 feet and discharging it into a tank from which another pump, 3, takes it and delivers it to the second tank. The pump 4 takes it and delivers it into the



Method for Lifting Water 60 Feet.

upper tank which is 60 feet above the river. This is the best way known for raising water 60 feet by suction.

Others have devised different ways for doing this, but the same principle underlies the whole operation, as water can only be raised by suction to a height that corresponds to the weight of the atmosphere, whatever that may be. The illustration given by "Scott" in the November issue, utilizes this principle and nothing more, the same as my illustration in this issue. The title given to his letter is misleading, also the one that I have given to mine by way of illustrating an erroneous expression, because when we speak of lifting water a certain distance by suction it is generally understood to mean that it is done at one operation and not by two or three. The only real difference between his plan and mine is that he shows it in two operations while mine shows three.

Whenever a plan is submitted whereby water can be raised by suction higher than the weight of the atmosphere warrants, it is taken as a new device for overcoming one of nature's well-known laws, but it is impossible to do this, because these laws cannot be circumvented and they do not change.

A certain engineer once made a statement before a meeting of steam engineers to the effect that he had raised water by suction about 40 feet. When questioned concerning the matter he said that it was done at one operation and by one pump, but persistent inquiry brought out the fact that while the suction pipe was about 40 feet lon, 15 feet of it extended downward below the surface of the water, while the vertical distance down to the surface was 25 feet. This man stated his experience with the intention of disproving the oft-repeated assertion that water cannot be lifted 40 feet by suction, but he forgot that the water stood 15 feet high above the end of his suction pipe before the pump was started, leaving only 25 feet for it to be raised by the pump.

I do not know whether "Scott" intended to follow this engineer's example or not, as his letter leaves it an open question, but it is naturally taken to mean this in the absence of a statement to the contrary. His illustration shows an ingenious contrivance that will work as he states, yet for general use, a deep-well pump will prove much more practical, provided he cannot set his direct-acting pump within 25 feet of the water to be lifted.

I notice that some of the advertisements published by pump makers state that their pumps will lift water 400 feet more or less. This appears to be a misstatement of facts, because after water has passed a pump it is then being forced to its destination; therefore is not lifted in a correct sense of the word. Furthermore, these advertisements in catalogues include the whole vertical distance through which water is raised, and it appears in one statement which is rather confusing until the matter is well understood. Of course, the work of raising it includes the entire distance through which it passes, but it is better to use the terms "lift" and "force" to distinguish the two operations and convey just what we mean.

New Haven, Conn. W. H. WAKEMAN.

Kerosene Not Good for Boilers.

EDITOR THE PRACTICAL ENGINEER:

In your November issue I see an article on the sixth page in regard to the "Care and Management of Horizontal Tubular Boilers", by Wm. Kavanagh. I was deeply interested in his remarks. As a whole, they are good, but, though I may not be as old in the business as Mr. Kavanagh, I must take exception to some of his remarks.

First, he says that a boiler should not be blown down the night before cleaning; that it should be left to cool gradually for three or four days. Now, I have never worked in but one plant where this was possible; they had a battery

of seven boilers and would let one off each Saturday night, and would clean it about Wednesday following. But this is the only instance in all my experience. Mr. Kavanagh also recommends kerosene as a scale preventive. I most emphatically disapprove of the use of kerosene in any quantity as a boiler compound. In my experience I have been led to believe that, instead of preventing, it really helps to form scale. I was firing in one plant in particular where kerosene was used as a compound, and—you may believe it or not—we removed scale from the tubes or flues over ¼ inch in thickness and from 18 inches to 2 feet in length. I also believe that when kerosene is used, it requires more fuel to run the plant. I agree with Mr. Kavanagh that too sudden changes in the temperature of a steam boiler are injurious, but in ninety-nine cases out of one hundred they are almost unavoidable. I am operating a horizontal tubular boiler 62 inches in diameter and 16 feet long with 54-4 inch tubes. This boiler is kept under steam night and day.

Every fourth Saturday I instruct the watchman, who is a licensed man, to pump her up to 3 gauges, and when his steam has dropped to 20 or 25 pounds to blow her down to 1 gauge and re-fill her, repeating this operation until she is cool enough to blow down, then re-fill her and let her stand until I come on duty Sunday morning, when I run off the water and proceed to clean out. I have followed this course for the last two years, using nothing but plain sal-soda for a compound, and I virtually have no scale, but I pump about two quarts of this diluted soda into the boiler each day, and I find it gives as good satisfaction as any of the many boiler compounds in the market; in fact, better than the average compounds. I would state, however, that I use Lake Erie water. My predecessor, who took charge of this plant when new, used kerosene and compounds for the eleven months that he operated the plant, and yet when I took charge there was nearly ¾ of an inch of scale in the back end of the boiler which, under the above treatment, has all disappeared.

Cleveland, Ohio. J. D. K.

Filling Oil Cups Prevented Boiler Explosion.

EDITOR THE PRACTICAL ENGINEER:

I am enclosing a clipping from a newspaper in reference to a boiler explosion in Fall River. I thought I had heard about all the different causes that would make a boiler explode, but this is a new one to me and I think other engineers will be interested. The account of the explosion follows:

"The courage of Thomas Hussey, a fireman at the Fall River Bleachery, very possibly prevented a serious accident about 7.30 o'clock Tuesday morning. Hussey, when all the other men in the fireroom fled in terror, climbed to the top of the boiler that threatened to explode, remedied the difficulty, and then, descending, pulled the fires from under the boiler.

"The trouble is said to have been caused by the oil cups on the top of one boiler of the battery by which the engines of the plant are run, becoming dry. This caused the boiler to give forth ominous sounds that so frightened the men in charge that, with the exception of Hussey, they fled for their lives. He, however, went up to the top of the boiler, filled the cups, and then raked the fires from underneath. There was no explosion, and the frightened men soon took their places again. The plant was run the remainder of the day by means of the other boilers of the battery.

The occurrence was not generally known by the operatives at the bleachery until half an hour later. It caused much comment and general commendation of Hussey's bravery, but no excitement."

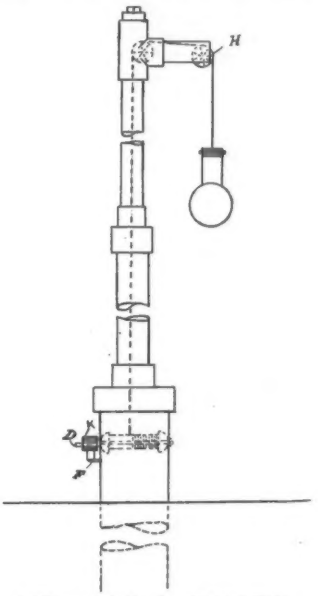
You, in your travels, I'm sure, have heard of some funny explanations, but I think this is a new one for you.

Fall River, Mass. M. H. H.

An Electric Light Pole Made From Old Steam Pipe and Fittings.

EDITOR THE PRACTICAL ENGINEER:

Here is an idea for an electric light pole, several of which are in use; they are made out of old steam pipe. The top or upper pipe is 2½ inches in diameter and about 15 feet long; the middle length is 3 inches in diameter, 15 feet long; the bottom pipe is 8 inches in diameter and 10 feet long. Six feet



A Home-Made Arc-Light Pole

of this bottom pipe are sunk in the ground. At D a square is formed for a handle so that the lamp can be raised and lowered. F is a spring which works as a ratchet on the cog-wheel K. Both the cord and lamp used are of light weight, the only piece of rope exposed to the weather is from the lamp to the pulley H. The rest of the construction can be understood by a glance at the sketch.

Toronto, Can. JAMES E. NOBLE.

Engineers' Examinations.

EDITOR THE PRACTICAL ENGINEER:

I have been reading the discussions of some of the writers on the question on engineers' examinations, and though much interested, have come to the conclusion that the engineer who always puts up the strongest "kick" about what has been aswed him, does not have the experience he should have, and no one knows that any better than he does himself; for, if an engineer is quite a practical man, he will take his medicine and come home like a little man and acknowledge he could not answer the questions asked, and get down to business and tackle it in the near future again instead of parading around abusing the law, the examiner and everybody else for something that is

absolutely his own fault. If an engineer gives up at the first attempt, he surely lacks ambition, and, of course, if he has no ambition, no one else will take any interest in him or help him.

As to the questions asked, no matter what they are or how practical, there is sure to be some one dissatisfied, and, of course, the one who is not satisfied, is the one who falls down on some of these. Of course, he abuses the law and the examiner, because he does not know. I do not know of a more abused man than the examiner or any one more misrepresented, and I, for one, do not envy him his position.

If an applicant who fails to pass a satisfactory examination would only get down to business when he gets back home again, with that ever strong determination to do or stick at it until he does reach the top or grade he is after, there would be less of this finding fault, especially with some one who is not responsible for what the applicant failed to know.

It is a hard matter for any examiner to be able to always justly judge the applicants, for oftentimes a person who is being examined knows just what he ought to say, but still he hesitates for fear he may be wrong and stumbles all over himself and tries to "beat around the bush", instead of coming right out with what he knows has been his experience. In answering this way he not only confuses himself, but also causes the examiner to doubt his ability, and, of course, the examiner must class him as he has answered. While again men who do not know, try to bluff the examiners, make one think they know when they never had any exeprience, and help to make it hard for others. There are many engineers who are inclined to give up when they run up against a hard problem or question during their time of study, with the excuse that it is too deep for them to see through and they do not see why so much red tape is used. I have heard men say: "I know all I want to; I will never need anything higher than I have."

These very same men sometimes see a chance to better their condition and there they make a dive for a better license to cover a position such as this may be, and they meet with the same old answer: "You have not passed a satisfactory examination; I cannot give you the license you have applied for. Go and study up and come back again, and I may be able to help you." Had this man been busy and preparing for something better if he did not get the position, he would have the satisfaction of getting a better license had he passed, and ready for some other job in the future.

No matter what the class is, let it be 1st, 2d or 3d, an engineer must have the experience and ability to fill the same; if he has not, what is the use of making such a disturbance when no one is to blame but his own self?

I often hear men say: "I never had any experience with a condenser or never ran a compound engine", and still this same person will go about swearing because he cannot have a first-class license, and you will hear the same man say: "I am just as good an engineer as so and so, who has a first-class certificate", while the first man has had to have the experience to get the license or else he would never have it, and at the same time the fellow who wanted to have the first-class license never put himself out to try to get the experience necessary to acquire it.

There is no excuse for anyone who wants to reach the top. If he does not have the ambition to hustle, why he cannot expect what others have who have been on the hustle all the years they have been at the business, and still more, he does not deserve it.

Every engineer has all the chance he wants to advance himself, if he will only make use of it; for there are the books and steam engineer journals that are doing everything possible to furnish him with valuable information on all subjects, and if he is anxious to read and study, there is not a copy of any engineers' paper printed but what there is ten times the cost of any information to him or, in fact, to anyone who wants to be abreast with the profession which, I admit, is quite a rapid pace these times. Then, again, are the Engineers' Associations with lots of able men as members, who are always, as a rule, ready and willing to do all in their power to help and lift up the brother who has not yet reached the top round of the ladder. Again, it is seldom anyone who would ask some engineer who has had experience in what he may wish to know, who would not be willing to tell him all he desired.

I would advise all engineers who are trying to reach the top to study hard. Do not allow anything to be too deep for you. If you cannot master the question, do not feel a mite ashamed, but go to some one who you think can and state what you want to know, and nine times out of ten you will be much wiser than you were before you inquired.

N. Abington, Mass. B. S.

The New Chief. Incidents and Instructions.

EDITOR THE PRACTICAL ENGINEER:

The editorial which appeared in the December issue of THE PRACTICAL ENGINEER struck me as being about right. As is stated, the first week which the engineer puts in at a new plant is the one which determines whether he has sufficient calibre to handle the plant or not. Not only does this apply to the large plant, but it applies to the smaller ones as well.

In assuming charge of a plant, the new engineer often looks for troubles which are imaginary, or which have been handed down as facts by the engineer who had charge before. To be a success in a plant requires a use of common sense, pure and simple, as a general thing.

Usually the new engineer will find that things are not arranged as he desires, and, therefore, he begins to make changes almost at the start. This is where he makes a mistake. He should fully understand his plant before even thinking about making changes, as very often there are good reasons why certain things are as they are.

Notwithstanding the fact that engineers are far more educated than formerly, there is a great deal of ignorance about the little things which come into their lives day by day. To cite a case: A certain engineer who had worked in a certain plant for about four years, and who had had charge of installing a new engine, found it to his advantage to find employment elsewhere. The load on the one boiler and engine was at times somewhat above the rating of either, and consequently the boiler fired hard, which was made more difficult because the stack was not of sufficient capacity.

The new engineer, upon taking charge, and who did his own firing, failed to observe that the method he had been using for years in another plant could not be used in his new position. There he fired up whenever the steam began to fall, and blew the tubes and cleaned the fire when he was obliged to. In the new plant it was absolutely necessary to have the fires cleaned and the tubes blown before the time of the heavy overload, which lasted for two or three hours, if steam were to be kept up.

This he neglected to do, and when the heavy load came on the steam began to fall and soon the entire plant was at a standstill and remained so for several hours. The trouble was that instead of using a little judgment and firing the boiler as it demanded, he put in a fire, and as the steam did not at once respond in went another quantity of coal, with the result that by the time the steam had fallen to a point where the engine refused to turn, the furnace was choked with coal. The engineer lost his place after this had happened several times, and all because he did not use judgment in firing a boiler, which clearly indicated that a thin fire was the only method of keeping up the steam, and that when the fires and tubes were clean.

I do not think there is any need of a new chief getting into trouble the first week, if he uses common sense. He will have many things to get acquainted with, but he does not have to do so all at once. His play is to lay low and see what is going on. This makes me think of an incident which happened when I first began enginering. I went to work in an electric light plant at a time when an entirely new crew was put on, the other men being discharged "for the good of the service." Among others was an elderly man, about 55 years of age, who had seven or eight years before operated in the same plant, and who was, therefore, supposed to know all about it. I had been engineer at the plant for two nights before this engineer came on and knew that the engine was running fine, although what kind of a card could be obtained from it was another question. The first night and before the engine had been started, Willson, we will call him—although that was not his name—got out a pair of dividers and began taking measurements on the rocker arm, reach rod and valve gear. As they did not all coincide with the marks which were put on the engine by the engine builders when the engine was new, seven years before, he concluded that the valve required adjustment, although he had not seen the engine operated for months. With his divider data he made a few adjustments, and then started up for the night's run.

It is usually this kind of engineer who falls down when taking a new plant, and is it to be wondered at? An engineer cannot jump at conclusions, for if he does there is a great liability that he will either jump too high or in a wrong direction.

Cleveland, Ohio. E. P.

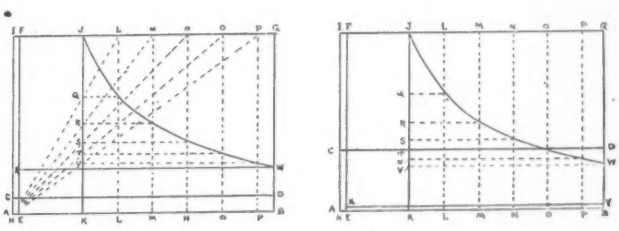
Theoretical Cards of Compound Engine.

EDITOR THE PRACTICAL ENGINEER:

In the article on the 2,500 horse power cross-compound vertical condensing engine question in the November issue, I stated that the drawing of the indicator cards, although theoretical, was not difficult. I will endeavor to prove so, and herewith show the high and low pressure indicator cards of the engine in question. I have shown only one end of each cylinder, that being sufficient to show the method.

In the first place, we must assume the length of the card and the scale of spring to be used. In Fig. 1 I have taken four inches as the length of the card, and 64 pounds to the inch as the scale.

In proceeding to lay out the card, Fig. 1, first draw the line A B, which represents the line of no pressure. Next draw lines E F and B G perpendicular to line A B, representing the length of the card. Then using a 64 scale, measure the distance E F equal to 175 pounds absolute pressure from line of no pressure A B and draw F G. Then measure on E F, distance E C equal to 15 pounds and draw C D, the atmospheric pressure line. Next draw H I representing the clearance in cylinder which can be assumed any value thought correct. In this case I have assumed about 2 per cent. or one-tenth of an inch on the card. Cut-off is ¼-stroke, so that the point J is one inch from F.



Method for Laying Down Theoretical Cards

Now draw J K, representing the volume of steam in the cylinder at 175 pounds absolute pressure at the point of cut-off.

In drawing the hyperbolic curve, the clearance should be taken into account. Take distance I J or ½ the distance for accuracy and measure off on the line I G distance equal to ½ distance I J, making points L, M, N, O and P. Draw dotted line L L, M M, N N, O O and P P at right angles to line I G and connecting A B. Next draw dotted lines A L, A M, A N, A O and A P intersecting J K at points Q, R, S, T and V.

At points Q, R, S, T and V draw horizontal dotted lines intersecting respectively lines L L, M M, N N, O O and P P. At the points of intersection of these lines the hyperbolic curve J W is drawn, the outline F J W X F being the theoretical card of the engine in question.

Fig. 2 is constructed in exactly the same way as Fig. 1, except the pressures and scale of spring X Y is the back pressure line corresponding to 28 inches vacuum, and the outline F J W Y X F is the theoretical card of the low pressure cylinder.

New Bedford, Mass. F. W. C.

Public Does Not Care. Echo of Lynn Boiler Explosion.

EDITOR THE PRACTICAL ENGINEER:

I believe that T. F. S., on page 23 of the December issue of THE PRACTICAL ENGINEER, is right when he says that the public does not care whether an engineer has a theoretical knowledge of engineering or not. Being able to answer a lot of questions does not make a man any more fitted to operate a boiler and engine, unless he puts his knowledge into practice, and about two-thirds of the questions asked an applicant for a license to operate a steam plant are entirely foreign to the steam boiler, which is the source of danger.

The duties of 99 out of 100 engineers are to take care of a boiler and engine, and when that is accomplished he has done all that he can be reasonably expected to do. He has no say whatever in the designing or construction of the apparatus which goes to make up his plant and, therefore, even though he did have the ability and knowledge to design and construct them, he would not be permitted to do so, because the manufacturer pays men to do that very thing and there are not many owners of steam plants who would listen to their engineer when he advised that a certain engine was not built rigid enough or that the boiler was not braced as it should be.

The argument would be that the manufacturers evidently knew their business when they built their machines, and that if they had been so much out of the way regarding strength they would have discovered the fact without the help of the engineer. Even supposing that the engineer could prove that the boiler was not braced enough, would the employer go to the expense of having new ones put in when the makers of the boiler have been satisfied to put either braces too small or in less numbers than the size of the boilers required? In my experience, I have found that the average manufacturer hangs on to a dollar as long as the next one, and that he does not make alterations in his equipment unless it is to save him money.

The state of affairs as cited by the engineer of the Harney Co., of Lynn, Mass., gives a good insight as to what a manufacturer will stoop to in order to save a little money. Having friends in the vicinity of that city I have received the papers containing an account of the boiler explosion which occurred on the morning of December 6.

The paper states that Engineer Dunning made the statement to the chief of police that he had noticed a crack in the boiler plate near the manhole on top of the boiler some time previous to the time of the explosion, and that he had called the attention of his employers to the fact and that he felt that the boiler was not in a safe condition. Later on the insurance inspector made an examination and assured the engineer that there was no danger.

This engineer knew that a cracked boiler was not safe. Every one knows that a crack in any portion of a boiler weakens it and, therefore, the boiler is not safe to operate. What good did all the questions that were "fired" at Dunning by the examiner, when he went to get his license, do in this case; and yet it seems to have been one of neglect, and gross neglect at that, on the part of some one, either the engineer or the boiler inspector, and if the owners knew of it (they deny that Dunning made any statement regarding the condition of the boiler) then they are also responsible for the explosion.

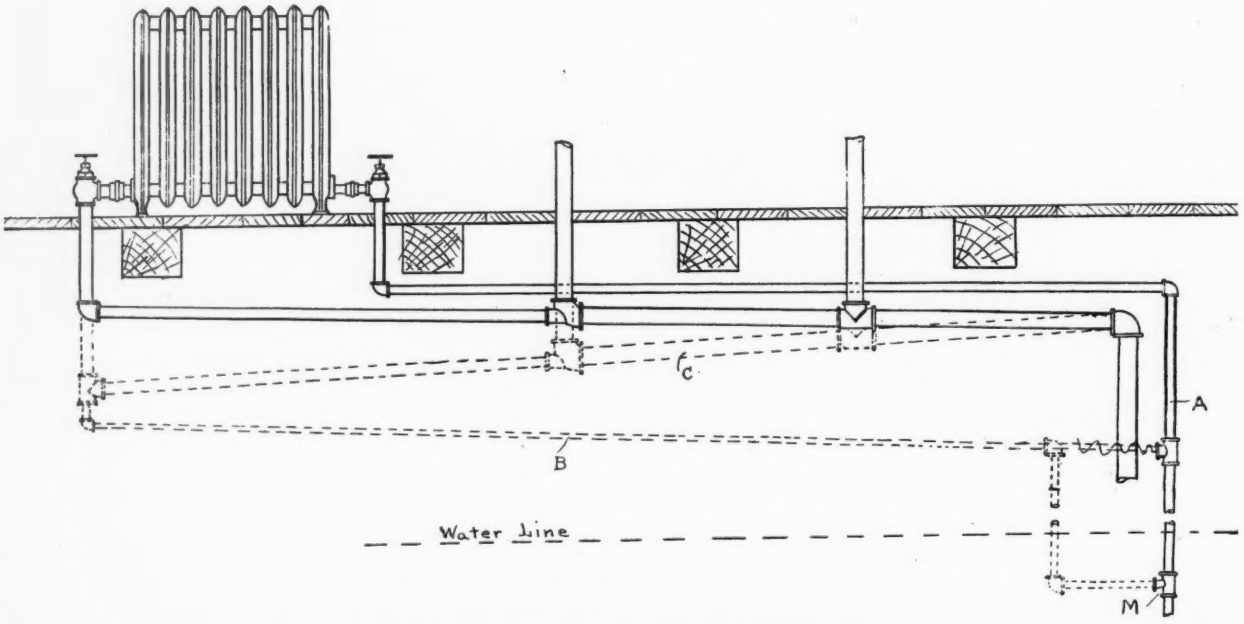
All the expert knowledge in the world could not have enabled him to make the owners of that boiler make repairs unless they so desired, and as they didn't want to, the boiler exploded.

Cleveland, Ohio. P. E.

Improvement for Radiator Drip Connections.

EDITOR THE PRACTICAL ENGINEER:

I have read with interest the article by W. H. Wakeman on page 13 of the December issue. There is one point, however, in which I think he has made an error of judgment. If steam travels along the dotted steam pipe at C, it will certainly allow any condensation at that point to escape along the dotted drip or bleeder B; but as soon as the water has escaped, steam, to a large extent, will flow along the drip and into the return pipe A, both above and below the tee. This will cause a slight check to the steam for a short time, water will collect and a pounding is certain to occur, and as the steam endeavors to push along the water it will raise slightly in the pipe D. By this time the steam under the tee on pipe A will have condensed, and the water will again flow out of the steam pipe.



A Suggested Improvement for Radiator Drip Connections

One way used by most of the practical steam fitters to overcome this trouble, is to lower drip B so that the outlet of the tee on A will be below the water line, as shown at M.

Toronto, Can. SCOTTY.

What Should be the Education of an Engineer? Method for Finding Cubical Contents of Tank.

EDITOR THE PRACTICAL ENGINEER:

To any one who has the best interest of the engineering profession at heart, the editorial which appeared in the November issue of THE PRACTICAL ENGINEER on the above subject must appeal most forcibly. The advice on the same subject, given by Capt. Crawford, U. S. N., should indeed carry a deal of

weight, and although the writer can hardly claim to have grown old (a defect which is being remedied every day) listening to the throb of the reciprocating engine, yet he considers he has had experience enough in designing, constructing and running at sea and on shore to take the liberty of expressing his opinion on the above subject. Having served a six years' apprenticeship myself, taking the several branches of the trade, I can fully indorse all Capt. Crawford has said regarding shop experience, and would go further and make it compulsory for a man to have at least four years' shop experience before he was granted either a marine or stationary license of any grade. If such were the case there would hardly be so much "ink slinging" about difficult (?) examination questions, any one of which questions a boy in the third year of his apprenticeship could answer; that is, if he was keeping pace in his studies and was desirous of becoming an engineer and not merely an engine driver.

Having expressed myself so far I would like (with your permission) to take advantage of the suggestion made in the last few lines of your editorial, and at the same time perform an act of charity by letting two of your correspondents in the November issue "see themselves as others see them."

Mr. J. C. Scott, in an article, entitled "What can be learned from Ads. and Catalogues", shows how easy it is to obtain a first-class Ohio license. They would never grant a license in "Missouri" on such a showing of knowledge and experience as he brags about, for he has the presumption to consider himself an engineer because he has picked up the A-B-C of a profession out of the waste paper basket—a profession in which a man has years of study before he discovers how ignorant he really is and how little he does actually know. This remarkable young man studied the different makes of engines, boilers, pumps, heaters, etc., from sketches and, most remarkable of all, he actually noticed for the first time that all manhole and hand-hole plates were invariably made oval and saw how braces were usually put in a boiler. I wonder if he had ever taken off a manhole plate to see the inside of a boiler? Possibly, before he saw the catalogue, he thought the braces were held in their place by glue or cement. After enumerating several other wonderful discoveries made from the study of ads. and catalogues, Mr. Scott states that none of his books explain how the steam gauge works; now, not knowing the extent of Mr. Scott's technical library, I can only suggest that he will find the desired information in any of the following authors: Jamieson, Clark, Lucus, Reed, Hutton, Seaton, all with an explanation of the "loop", which worried Mr. Scott so much.

Another of your correspondents who "has had a great deal to do with installing and running of oil-burning systems in the largest factories and steamers in the State", asks for a rule for figuring the capacity of each inch of tank as the supply diminishes. I think the following rule will save M. L. S. time and trouble of carrying a table of heights and areas around with him, and at the same time will save him the necessity of doing any more "rough guessing."

Rule:—Divide the height of the segment cubed by twice the chord, and add the quotient of two-thirds the product of the chord multiplied by the height of the segment, or,

$$\text{Area of Segment} = \frac{H^3}{2C} + \frac{2}{3}CH$$

in which

H = height of segment
C = Chord

which, if applied to tank 20 feet by 6 feet, given by M. L. S., becomes

$$\frac{.125}{2 \times 3.3} + \frac{2}{3} 3.3 \times .5 = 1.189 = \text{Area of Segment}$$

then

$$1.189 \times 20 = 22.378 = \text{cubic capacity of segment}$$
$$22.378 \times 7.48 = 167.397 = \text{gallons consumed}$$

and

$$4229.85 - 167.397 = 4062.45 \text{ gallons}$$

remaining.

For the benefit of M. L. S. and his friends, who may not know how to get the chord of the segment, the rule is as follows: Square the two given sides, subtract the lesser from the greater and extract the square root of the difference.

In conclusion, I would advise M. L. S. in the future simply to ask for information, and not show his ignorance by stating that he got his consumption by allowing 2.5 pounds of oil per horse power, as Eastern men may think we all know so little about burning oil because we happen to live in the

San Francisco, Cal. "GOLDEN WEST."

Scheme for Water-Works Engineers.

EDITOR THE PRACTICAL ENGINEER:

I am engineer of the water-works here and I think I have a little scheme which might interest other engineers. We have a one million gallon reservoir 100 feet in diameter. Heretofore we have been much annoyed with more or less *algae* accumulating on top of the water in hot weather. I therefore ran a ¾-inch line of pipe out to it and connected on the city mains, and when the *algae* appears I just open my faucet, which has a ¼-inch nozzle screwed on, and the accumulation disappears. The pipe must be connected nearly tangentially to the side of the tank, as turning the water underneath or through the centre does no good. In this way it creates a current, and when the *algae* gets under the spray it gets ducked and disappears.

Whitewater, Wis. J. R. W.

A New Massachusetts Inspector.

Mr. J. H. Mac Rae, of Dorchester, has just been appointed a State boiler inspector to succeed Louis Amell, who died recently. Mr. Mac Rae was born at Braintree, thirty-four years ago, and has had sixteen years' practical experience as an engineer. He has been with the West End Street Ry. Co. in their Central and Dorchester Stations; with the Quincy Storage Co., where he was in charge, and at the South Station Terminal. For three years he erected turbines for the Westinghouse Company. He is a member of I. U. S. E., No. 16, and N. A. S. E., No. 1, of Boston.

West Virginia State Convention of the N. A. S. E.

The West Virginia State Convention of the N. A. S. E. will meet in Wheeling, W. Va., on January 4th and 5th, 1907. There will be liberal amusements provided, and arrangements have been made for a display of engineering exhibits. Further particulars about the convention can be obtained from J. R. Afoller, Chief Engineer, Mutual Bank Building, Wheeling, W. Va.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

What is the Matter with This Dynamo?

EDITOR THE PRACTICAL ENGINEER:

I have a generator of 25 kilowatts capacity used for lighting only, and I would like to know a remedy for the excessive heating of the commutator. Also, about twice a month, while it is running with the load on, it will stop generating, and the only remedy to get it started is to bear a piece of fine sandpaper on the commutator; then it will start generating and pick up its load. The machine acts the same with an underload as an overload, in both cases. What causes it?

Tippecanoe, Ohio. S. K.

What Causes the Pump to Pound?

EDITOR THE PRACTICAL ENGINEER:

Can you advise me of the possible cause and a remedy for a pump pounding? This pump is a 6½ x 5 x 6 Snow, and is used only during the summer; consequently the piston rods have become rusted by not being properly taken care of and bind a little. The steam pressure ranges from 60 to 100 pounds, and the water pressure 40. There is an air-chamber on the suction pipe, and I have set the eccentric valves as near as they can be set. The exhausts are not even, and when the pump is run at a low rate of speed it will not take the full length stroke. Any information you might put in any future number would be appreciated greatly by me.

Albany, N. Y. B. L. K.

Horse Power of Fan.

EDITOR THE PRACTICAL ENGINEER:

What horse power does it take to run a blower to drive a fire for a 100 horse power boiler? The blower has a suction of 10 inches and a discharge of 8 inches. The fan is 20 inches in diameter and revolves at 2,500 revolutions per minute.

Whitewater, Mich. J. R. W.

Assuming that the blower is working against two ounces pressure, it would require about 8.1 horse power if driven at its rated capacity.—[ED.]

Massachusetts Second-Class License Questions.

EDITOR THE PRACTICAL ENGINEER:

I would like to know the answers to a few questions asked me by an inspector in Massachusetts when I applied for a second-class license a short time ago.

1. How many ports are there in the steam end of a single cylinder direct-acting Deane steam pump?

2. What is the difference between an injector and inspirator?

3. If a pump was pumping water into a boiler from which it was taking steam at 80 pounds pressure, and a valve was then opened letting the water into the atmosphere and it stopped throwing water, what would you think was the matter with it? The pump is apparently working all right on the outside and there are no leaks in the suction; there is nothing under the valves, and the suction and delivery is not clogged.

Mt. Tom, Mass. F. S. H.

1. Five ports: four steam and one exhaust.

2. Practically nothing, except the name.

3. We would be pleased to hear the opinion of our readers on this question.

Chimney Draft. Rites Governor. Measurement of Threads.

EDITOR THE PRACTICAL ENGINEER:

I wish you would answer the following questions in your next issue:

1. Explain how to measure the draft of a chimney and how to attach to the chimney.

2. Give me a rule to figure out the size of steam header when I know the sizes of pipes leading from it.

3. Explain how to regulate the speed of an engine equipped with a Rites governor, and explain how it acts on the eccentric.

4. What is the proper way to measure threads on a bolt?

C. E.

1. The usual form of draft-gauge is a glass tube bent in the shape of the letter U. One leg is connected to a tube leading to the chimney by a small rubber hose, while the other leg is open to the atmosphere. A scale marked in tenths of an inch is generally fitted between the two legs of the gauge. The glass tube is partly filled with water, which will, when there is no draft, stand at the same height in both legs, provided the gauge is perpendicular, which is its normal position. When connected to the chimney the suction caused by the draft will cause the water in the leg, to which the hose is attached, to rise, while the level of the water in the leg that is open to the atmosphere will be equally depressed. The extent of the variation of the level of the water is a measure of the draft.

2. If it is desired to make the area of the header equal to the area of the pipes leading from it, find the area of each pipe by squaring the diameter and multiplying by .7854 and adding the areas together; the result is the area of the header. By dividing by .7854 and extracting the square root, the diameter of the header is found. This is the smallest diameter that should be used.

3. The speed of an engine equipped with a Rites Governor can be regulated within limits by changing the tension of the spring which controls the governor weights. If the speed is too fast, it can be reduced by increasing the tension of the spring, and if the speed is too slow, decreasing the tension will increase the speed. When the engine is at rest the eccentric pin is at a certain distance from the centre of the shaft. When the engine approaches its normal speed, the governor weights fly out and the eccentric pin moves toward the centre of the shaft, so that when the engine is at its exact speed the eccentric pin occupies such a position that it controls the steam valve by cutting off steam at the proper point. If, then, the engine tends to move faster, due to a decrease of load, the inertia weights tend to fly outward and the eccentric pin moves inward, cutting off the steam at an earlier part of the stroke,

thus maintaining equilibrium between the internal and external forces. When the load on the engine increases, the governor weights cause the eccentric pin to move farther from the centre, cutting off steam later in the stroke, which increased energy brings the engine back to its normal speed.

4. If the thread is of any standard size it can easiest be measured by laying a scale across the threads. The number of threads per inch can then be measured, from which the pitch and the depth of the thread can be obtained. The pitch in every single thread is the distance from the centre of one thread to the centre of the next thread; if double, the distance between every other thread is the pitch. If the bolt is standard, measure the diameter, and a bolt-table will give all other dimensions of the thread.—[Ed.]

Electrical Questions.

Editor The Practical Engineer:

Will you please answer me the following questions through your valuable paper?

1. What is the difference between a closed coil and an open coil winding?

2. What is the function of a commutator?

3. What opposes the free rotation of the armature when the dynamo is under load?

4. Why must the brushes be shifted from the neutral plane with the increase in load?

5. Describe the operation of the equalizing rings.

6. Explain why both the series and shunt coils are required to make a dynamo self-regulating.

Linwood, Neb. W. F. J.

1. The open coil armatures, which are used principally on arc dynamos, are so named because no closed circuit can exist in their windings; the outer circuit has to be connected to the brushes to give a closed circuit. A closed coil armature has its windings so connected as to form a closed circuit.

2. A commutator is used on a generator when it is desired to get a direct current from the coils. The brushes on the commutator are so placed that at the instant the induced electromotive force changes its direction, the brushes slide across from one segment of the commutator to the other, and thus the current, while reversed in the loop, is left flowing in the same direction in the outside circuit.

3. The torque which is produced by the magnetic field on the armature of a generator must be overcome by some external force, and the greater the amount of current flowing through the armature coils and the greater the intensity of the magnetic field, the greater is the external force required to revolve the armature.

4. Brushes must be shifted from the neutral plane because armature reaction varies under different conditions of load. The neutral points vary according to the relative intensities of magnetization of the field magnets and armature cores.

5. The equalizing or collector rings of a three-wire generator are connected to a pair of auto-transformers or balance coils. These balance coils have a single winding about a laminated iron core and are immersed in oil. The mid-points of the balancing coils are inter-connected, and from this connection a wire is led to the neutral of the three-wire system, thus balancing the inequality of the load on each side of the circuit.

6. A shunt machine, when the resistance of the outer circuit is reduced, falls in voltage owing to the decreased amount of current passing through the shunt coils. To increase the amount of current passing around the field coils, series coils are added so that as the current in shunt fields decreases, the current passing through the series field will make up the decreased magnetism and keep the voltage constant. If the series coils were used alone, the voltage of the generator would increase as the load increases. By thus giving the proper proportions to the two exciting coils, the intensity of the field can be kept practically constant as the current in the outer circuit is increased or diminished.—[Ed.]

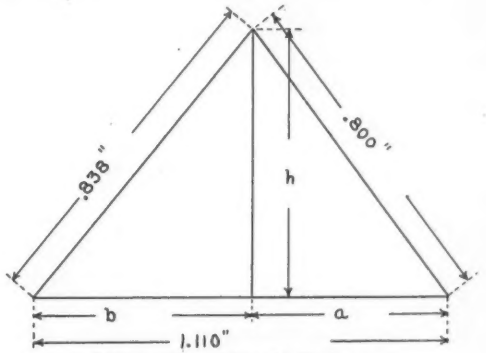
A Triangle Problem.

Editor The Practical Engineer:

In the given triangle, the three sides are 1.110, .838 and .800 inches, respectively. Will you please calculate for me the length of each division of the base as a and b and also the altitude h?

St. Louis, Mo. A. O. S.

The rule for finding the lengths a and b and the height h, when the three sides of a triangle are given, is as follows: As the base is to the sum of the sides, so is the difference of the sides to the difference of the divisions of the base made by drawing the perpendicular. Half of this distance being added to or subtracted from half the base will give the two divisions thereof. As each side of the triangle and the adjacent division of the base forms a right-angle triangle, the height can be obtained by squaring the hypothenuse and the base, substracting and extracting the square root.



Illustrating Triangle Problem

Working out the above problem according to the rule, we have

$$1.11 : (.838 + .8) = (.838 - .8) : a - b$$
$$1.11 : 1.638 = .038 : a - b$$
$$1.11\,(a - b) = .062244$$
$$a - b = .056$$
$$\tfrac{1}{2}\,(a - b) = .028$$
$$\tfrac{1}{2} \text{ of } 1.11 = .555$$

therefore

$$a = .555 - .028 = .527$$
$$b = .555 + .028 = .583$$

then

$$h = \sqrt{.838^2 - .583^2} = \sqrt{.3603}$$
$$h = .60 \text{ inches}$$

The lengths of the two divisions of the base are therefore .583 and .527 inches, respectively, and the height is .60 inches. —[Ed.]

Hydraulic Fits. Connections for Grounds.

EDITOR THE PRACTICAL ENGINEER:

I would like to ask a few more questions through the columns of your valuable paper.

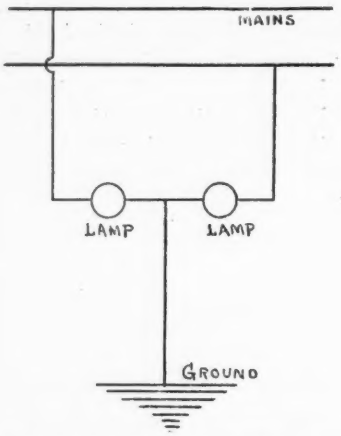
1. I would like to know approximately the pressure that locomotive drivers, crank pins and crank discs of stationary engines, car wheels and other hydraulic fits are put on with.

2. How would you connect up two dynamos of 250 volts, tandem style or in series, so as to have an equalizing wire between the machines?

3. How can a lamp be connected to burn down and brighten up in case of a ground?

Lamoine, Cal. J. E. G.

1. The question of the pressure required for forcing in hydraulic fits is usually a matter of experience. When turning a crank pin to fit in a crank or any piece of metal to fit a hole, it is usual to allow the diameter of the pin to be $^1/_{10}$ of 1 per cent. larger than the diameter of the hole into which it is to fit. Various engineering concerns allow different pressures; for instance, the E. P. Allis Co., of Milwaukee, allow a pressure of 10 to 16 tons per inch of diameter; the Baldwin



Connections for Locating Grounds

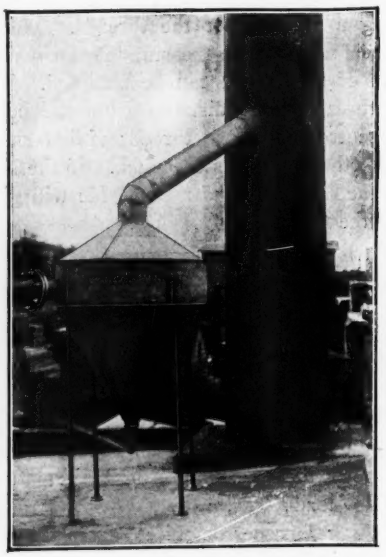
Locomotive Works allow the same pressure for axles, and so do the Pennsylvania Railroad and various other shops, whereas, some of the stationary engine builders allow only a pressure of 4 tons per square inch of diameter; while the Schenectady Locomotive Works allow 10 tons for axles, and from 5 to 8 tons for crank pins. The Union Iron Works, of San Francisco, Cal., endeavor to obtain from 200 to 500 tons per square inch of contact surface.

2. Two dynamos should be connected in series if an equalizing wire is used. The voltage obtained will then be either 250 or 500 volts as desired, depending upon whether the connection be made across the outside main and the equalizer or the two outside mains.

3. The accompanying sketch will show the method of connecting up lamps so that they will burn bright or dim in case of a ground. If there is no ground upon the circuit, the lamps will take one-half of their normal current and show a deep red; but if a ground should occur on either line, one of these lamps will be short-circuited and decrease in brightness, while the other lamp will burn nearly to its normal candle power.—[ED.]

The "Unique" Turbine Exhaust Head and Draft Generator.

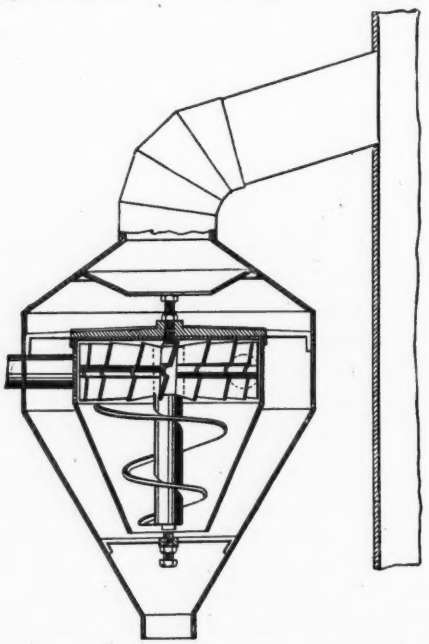
There are two important considerations that enter into the operation of power plants using soft coal, namely, the obviating of the smoke nuisance and the decreasing of the back pressure on the engine. If the smoke is prevented from form-



Method of Installation of the Unique Exhaust Head

ing, more complete combustion is attained, and if the back pressure on the engine is reduced, the engine is capable of doing a certain amount of work with a less amount of steam.

Advantage of these two facts has been considered in the



Section View of the Unique Exhaust Head

design of the Unique Turbine Exhaust Head, with the result that a turbine head, a water and oil separator, smoke consumer and draft generator, have been embodied in the one piece of apparatus.

The construction and operation of this device, shown in the

accompanying illustrations, is as follows: The exhaust head has one or more inlets, so that it can be connected to one or more engines or pumps without in any way affecting its operation. The exhaust steam enters the exhaust head through the side branches in the turbine housing, and sets the turbine in motion rapidly. The water and oil in the steam is forced in the worm below, from which it flows by gravity to the hot well. The steam then rises up from the inside of the turbine housing perfectly dry and is carried to the stack, where it acts as an induced draft, and, combined with the air system in the furnace, is said to give perfect combustion. With this turbine in use fuel of any kind, including soft coal, shavings and rubbish, may be burned with little if any smoke.

This combination, therefore, not only does away with smoke, thus increasing the efficiency of the plant, but it also relieves the engine of all back-pressure and sometimes creates a partial vacuum, and at the same time gives absolute assurance that the buildings will be protected from the oil and moisture from the steam exhaust. The whole system works automatically. Starting and stopping with the engine, it is easily installed, and is self-sustaining. For further information address the Unique Engineering Co., 5 Beekman Street, New York City, J. B. Hackett, Sales Manager.

The Grant Combined Inertia and Centrifugal Governor.

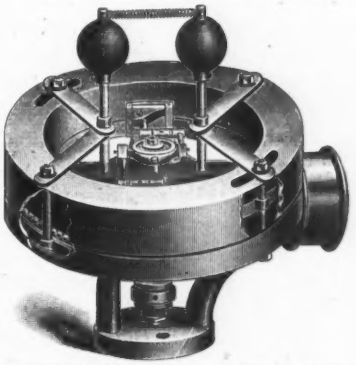
The best method of governing steam engines depends upon the proper relation of the forces due to centrifugal force and the force of inertia. The centrifugal force tends to make the governor sensitive with a change of speed, and the moment of inertia causes the governor to be stable.

The governor, recently devised by Charles Grant, of 224 Tompkins Avenue, Brooklyn, N. Y., utilizes the advantages of these principles, and both inertia and centrifugal force are used for controlling the cut-off. As shown in the accompanying illustration, the governor consists of two fly-balls to which a spring is attached, and two rings, one of which is a rigidly driven ring and the other an inertia ring of the same diameter resting on balls located in races cut in the facing surfaces of the two rings. The two governor balls are pivoted to the knuckles of two pairs of toggle links which connect the two rings, and a cam and lever mechanism is used to transmit any relative motion between the two rings to the governor spindle.

The upper or inertia ring is provided with a hyperbolical curved slot into which the levers that actuate the valve stem are engaged. The shape of this slot is so designed that the governor spindle will be moved practically the same distance by the same change of speed at all points within the range of the governor. The web on the lower ring carries two posts in which pivoted levers work. One end of each lever extends into the curved slot in the inertia ring, while the other engages with the collar on the governor spindle.

The operation of the governor is as follows: If the driving ring accelerates, the toggle links connecting the two rings are so arranged that the knuckles on which the balls are mounted will be drawn outward, and as the speed is increased the balls will be thrown outward by the centrifugal force, thus producing the same relative motion between the two rings; therefore, any sudden change of speed causes the inertia ring and the balls to co-operate in moving the governor spindle and thereby altering the cut-off. The action of centrifugal force on the balls is opposed by the spring between the balls. Any relation between centrifugal force and inertia can be maintained by the tension of this spring.

In practice it is found that an engine cannot be started immediately at full speed, the governor acting so as to close the



The Grant Centrifugal and Inertia Governor

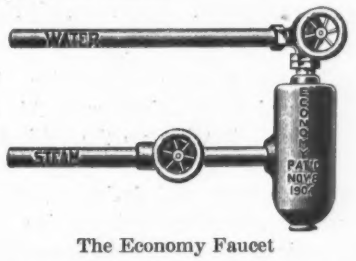
valve when about one-half speed is attained, then opening gradually until the normal speed is attained, thus preventing any possible accident to the engine when the throttle is thrown wide open at the start.

The Economy Faucet.

In almost all manufacturing plants there is a necessity for hot water in different parts of the plant, especially for such use as "washing up" of the employees at noon and night, or for such other purposes where hot water is used intermittently.

A device which has been used extensively for this purpose is the Economy Faucet, shown in the accompanying illustration. It constitutes a cheap and effective means of obtaining hot water at a moment's notice without special piping, and it permits both hot and cold water to be drawn from the same source.

The chief advantage of this device lies in the fact that no tanks or hot water pipes are required, and as many manufacturing plants constantly require more or less hot water and are not piped with hot-water plumbing, it is only necessary to run a steam pipe to the faucet.



The Economy Faucet

The steam pipe is led into the side of the faucet and water pipe leads into the top. When cold water only is required, the top valve is opened; if hot water is required the steam valve is opened and the cold water is turned into warm or hot water, any temperature being obtained by regulating the steam valve.

These faucets are made in two sizes: the one-half inch size for sinks or where small quantities of water are used, and a one and one-quarter inch size for dyers, bleachers, brewers, tanners and factories that require a large supply of hot water. They are sent on 30 days' trial by the Economy Faucet Co., 79 Weybosset Street, Providence, R. I. This company will also furnish any other information desired.

Book Reviews.

Elements of Gas Engine Design, by Sanford A. Moss. Size, 3¾ x 5¾. 197 pages. Published by D. Van Nostrand Co., New York City. Price, 50 cents.

This book is a reprint of a set of notes accompanying a course of lectures delivered at Cornell University a few years ago, and of articles from various technical magazines. It contains a general outline of the physics and chemistry of the gas engine and a discussion of gas engine fuels. Four chapters are devoted to the discussion of the action of gas in a gas engine cylinder which lead up to chapters which briefly outline the more important principles of gas engine construction and formulas used in modern American practice. Four tables on the properties of elementary gases, on sample gas mixture calculations, on properties of gas mixtures and mean effective pressures are included in the reading pages.

While, of course, the whole subject of gas engine design cannot be treated in such a small book, yet it contains more information than will be found in many books two or three times the size or cost.

———o———

The Steel Square as a Calculating Machine, by Albert Fair. Size, 5 x 7½. 81 pages, illustrated. Published by The Industrial Publication Co., New York City. Price, 50 cents.

That the steel square can be used for other purposes than testing the squareness of the work is set forth in this book, which describes a number of problems that can be solved by the common steel square without any calculation whatever and without any necessity for laying down elaborate diagrams.

There is nothing new about any of the problems shown in the book, all of which, more or less, depends upon several well-known propositions in geometry; but it is the author's desire to set these facts before the average mechanic clearly. It could, however, have been written in less rambling style, so that its statements would be more direct and so that the persons for whom it was written could understand it better. Negative information is seldom valuable, and is very apt to be misconstrued except by the discerning reader.

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Economics of Road Construction, by H. P. Gillette. Size, 6 x 9. 50 pages, illustrated. Published by The Engineering News Co., New York City. Price, $1.00.

To any one interested in the construction of various kinds of modern roads and their maintenance, this book will give valuable information. It takes up the subject of earth road and earthwork, which includes the profile of cross-section, longitudinal profile, gutters and drains, embankments, cost of earthwork surfacing, traction and tractive power. Gravel roads, telford roads and macadam roads are then taken up in detail, the latter including the quality and wearing powers of stone, spreading, rolling and spunkling. Systems of repairs and maintenance are discussed, together with suggested improvements in existing road specifications.

The book is well written and illustrated, and should prove valuable to any one interested in the subject upon which it treats.

———o———

Switchboards, by William Baxter, Jr. Size, 5½ x 8. 190 pages and 150 illustrations. Published by the Derry-Collard Company, New York City. Price, $1.50.

This book deals with switchboards of both direct and alternating current for power, light and railway service, and also contains a section on switches, circuit-breakers and lightning arresters. Starting out with simple switchboards, the book takes up successively the parallel operation of generators and their connections to the switchboard, the construction of switchboards, distributing systems, arc lighting switchboards, single-phase, two-phase and three-phase switchboards, and the various instruments used. The last part of the book deals with the various kinds of switches used, various forms of circuit breakers and types of lightning arresters.

The book is full of good pointers and illustrations, and is written in a clear, concise manner.

———o———

Marine Engineers: Their Qualifications and Duties, by E. G. Constantine. Size, 5 x 7. 320 pages and 84 illustrations. Published by D. Van Nostrand Co., New York City. Price, $2.00.

The object of the author in writing this book was to bring all the necessary facts pertaining to the qualifications of a marine engineer to the attenion of those outside the circle of the profession, and especially to any aspirant to that profession.

The book includes chapters on the scholastic education and training necessary for the proper understanding of marine engineering, apprenticeship, journeyman engineer, history of the marine engine, development of the marine boiler, water-tube marine boilers and several valuable chapters on the duties of junior sea-going engineers, such as keep watch at sea, boiler management, bad weather, off watch, break-downs at sea to engines, shafts or boilers. The book concludes with general rules for board of trade examinations and questions asked at those examinations.

———o———

Air Compressors and Blowing Engines, by Chas. H. Innes. Size, 5 x 7. 290 pages and 285 illustrations. Published by D. Van Nostrand Co., New York City. Price, $2.00.

This book should be useful chiefly to designing engineers. It digs right into the theory of the physical properties of air, using the well-known laws of the expansion and compression of gas as a foundation, and in the evolution of the various formulas, the theory of exponents and the calculus are frequently used. Experiments with compressors and valves for producing equalization of pressure are two of the subjects treated, after which the major portion of the book is devoted to types of blowing engines and air compressors. These latter chapters take up in detail each individual machine manufactured in this country and in Europe.

The book is extremely technical throughout and has many illustrations, but the majority of them are made on such a small scale as to be useless for the purpose intended. Many useful facts can be gathered, however, if one is able to wade through it.

———o———

Practical Metal Turning, by Joseph G. Horner. Size, 6 x 8½. 404 pages and 488 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $3.50.

This subject, which is of much importance to all who must work at a lathe, is treated in a full and exhaustive manner. The various methods of turning are described and all the different kinds of chucks are shown. Drilling, boring and allied operations are interestingly treated, and the important subject of thread-cutting is gone into thoroughly. The chapter of

high-speed steels is quite important in these days, as the greatest improvement of lathe work has been along these lines.

The book, in general, is well-written and illustrated profusely, and should prove an excellent reference book to practical machinists, engineers and amateurs.

Stationary Engineering, by Joseph G. Branch. Size, 6 x 8. 930 pages, 298 llustrations and 23 useful tables. Published by Perrin & Smith Printing Co., St. Louis, Mo. Price, $3.50.

Although the scope of this subject is very broad, the above book attempts to give all the underlying principles of power and heating plants together with such data on the subject of mechanical and electrical engineering as is deemed necessary in the successful operation of power and heating plants of every description.

Beginning with the subject of steam boiler, the various chapters include the subjects of combustion, boiler installation, boiler accessories, boiler management, types and specification of boilers, boiler and furnace attachments, boilers for heating purposes, boiler trials, steam engine, governors, valve gears, condensers, compound engines, pumps, electricity and magnetism, dynamos and motors, elevators, steam engine indicators, mechanical refrigeration, and laws and regulations for the inspection of boilers and licensing of engineers and firemen.

While there is nothing particularly new in this book, it brings together the various subjects which are generally to be found in a number of other books. Each subject is therefore treated in a more or less brief manner and in a practical way. The illustrations, however, are generally very poorly executed, especially the line cuts, but considering the price of the book for its size, the reader certainly gets his money's worth.

Tools for Machinists and Woodworkers, by Joseph G. Horner. Size, 6 x 8½. 335 pages and 456 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $3.50.

There is an old saying that a workman is known by the tools he uses, so that any information relating to tools, as used in general shop practice, is generally received with much favor, especially in these latter days when the average workman is not allowed to make or grind his own tools, in which case he becomes more or less helpless when thrown on his own resources.

The above book describes and classifies the various forms of cutting tools and tool angles for machinists and woodworkers: shearing tools, scraping tools, saws, milling cutters, drilling and boring tools, taps and dies, punches and hammers, and the hardening, tempering and grinding of these tools. The modern instruments of measurement and their uses are also described, including surface plates, levels, dividers, gauges, calipers, verniers, micrometers, etc.

The illustrations are very numerous and well-executed, and the information given is strongly practical. It should prove very useful to any one who is required to make and grind his own tools.

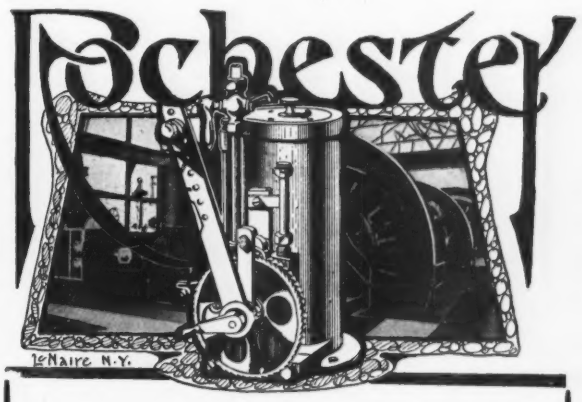
Punches, Dies and Tools, by Joseph V. Woodworth. Size, 6 x 9. 490 pages and 702 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $4.00.

As the literature on this subject is rather scarce, the above book fills a want which is no doubt much felt among practical men having dies, punches and tools to make for various kinds of machinery. Simple and intricate bending dies; cut, carry and follow dies; notching, perforating and piercing punches; composite, sectional, compound and armature disc and segment punches and dies; various processes and tools for making cartridges, cartridge cases, drawing wire and bar steel, pens, pins and needles, spoons, forks, watch and clock work, paint and chemical tablets, and many other forms of dies and processes for which they are used are described.

The use of dies and punches has become so universal in almost all manufacturing fields that the book should find favor among the class of artisans who have this kind of work to perform.

The uncertainty of hydraulic power was recently illustrated at Merwinsville, Conn., where, owing to the breaking away of the canal leading to the power house, the plant was put out of service; New Britain and Waterbury were put into darkness, and all the trolleys in the vicinity were tied up. Not long before this accident the plant was suffering from drought.

Steam piping should always pitch for drainage in the direction of the current of steam, and horizontal pipes should have a fall of at least one inch in every ten feet run. If horizontal pipes of unequal diameter must be joined, an eccentric flange on the smaller pipe should be used so that the bottom of the pipes on the inside shall be level to facilitate drainage.



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If your engine room is not equipped with Force Feed Lubricators, it should be, for without them you are not securing by any means full service value for every unit of fuel used, nor have you reduced wear and tear on the moving parts to as low a point as possible, or your oil bills by half.

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TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

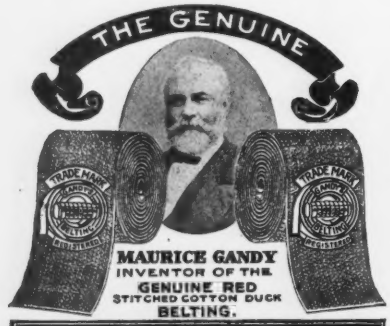
The Norbert Wolff Company, 472 Greenwich Street, New York, have issued an interesting, descriptive and testimonial pamphlet relative to their Belt Dressings for both Leather and Rubber Belting, copies of which may be had by the trade upon request.

The Wolff Company are doing a rapidly increasing business that shows a steady monthly growth and at the present time are billing out four times the "Wolff Dressing" they did in November, 1905.

They claim for their oil Leather Belt Dressing, as against paste dressing, that it is more economical in that it requires less, it does not "gum," but works into the leather and acts as a preservative.

The "Wolff Dressing" carries with it the positive guarantee of the Company, and to show its sincerity and belief in the result of any practical test, the Norbert Wolff Company offer to send any responsible concern for trial, a three or five gallon can, charges prepaid, and if at the end of thirty or sixty days the dressing does not prove to be all it is represented, the unused portion can be returned and the invoice cancelled.

The Hub Machine & Tool Co., 621-23 Cherry Street, Philadelphia, now have a large and well-equipped machine shop with special tools and a force of expert mechanics skilled in the work of repairing engines, pumps and all kinds of power plant equipment. They also maintain a department for building all kinds of special machinery and will be glad to communicate with persons wishing estimates on anythink in these lines.



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And your expectation will certainly be realized for Gandy belts—through service only—out distance Rubber and Leather belts easily. Then the price—so reasonable—adds to a Gandy's popularity.

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The Williams Gauge Company want to send their large steam specialty catalog to all engineers who happen to be interested in feedwater regulators, steab traps, pump governors or any of the other specialties manufactured by them. Address Williams Gauge Co., Mt. Oliver Post Office, Pa.

A copy of the special Christmas number of the "Penbertly Engineer and Fireman" will be mailed free to any reader upon request. Address Penbertly Injector Co., 344 Holden Avenue, Detroit, Mich.

ENGINEERS. Send your address, and *who employed* by, and we will send you a *Set of Corliss Valve Rod,* or *Throttle Valve Stem Packing free of charge. Express prepaid.* Give *diameter of rod, Gland, and depth of box.* Ideal Metallic Packing has no *equal.* We have the documents to prove it. Ideal Metallic Packing Co., Box 52, St. Paul, Minn.

One setting only is required on the
RUNNERLESS SLIDE RULE

to solve any of the following three proportions: $a:b=c:d$, $a:b=c^2:d$, $a^2:b=c^2:d$. New Method of Operating explained in Booklet. F. F. Nickel, 27 Winans St., East Orange, N. J.

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Works on any voltage; satisfaction guaranteed. Postpaid to any address on receipt of price (coin). J. H. Gravell, 1005 Drexel Bldg., Phila., Pa."

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A new preparation for enriching oils.
Will suspend in oil.
No more Hot Journals.
Engineers who have tried same claim it to be the best yet.
SEND FOR SAMPLE
A trial will convince you
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GRAPHO MFG. CO.
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A Valve File
is a useful and substantial tool for keeping the seats of Jenkins, or other valves with flat seats in perfect condition. A few turns make the seat as good as new. From ⅜ to 2 inches inclusive $10.00.
W. H. WAKEMAN
64 Henry St., New Haven, Conn.

A new style of faucet from which both hot and cold water can be drawn from the same pipe by connecting a small steam pipe to side of faucet is described in a circular issued by the Economy Faucet Co., 97 Weybosset Street, Providence, R. I.

Louis Bernhard, who was formerly located in Bridgeport, Conn., has moved to 184 Summer Street, Boston. Mr. Bernhard makes a specialty of setting boilers in connection with which he guarantees a saving of not less than five per cent. He claims to have the only boiler setting in America that is patended.

EVERY LIVE ENGINEER SHOULD HAVE THESE

BOOKS

THE CORLISS ENGINE, by John T. Henthorn, and "The Management of the Corliss Engine," by C. D. Thurber. This is a practical hand-book for Engineers and their Assistants. 52 illustrations, attractively bound in cloth. Price, $1.00.

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DIAGRAM OF THE CORLISS ENGINE. Makes it easy to know more about the Corliss Engine. Longitudinal Section of Engine Cylinder, showing Relative Positions of the Piston, Steam Valves, Exhaust and Wrist Plates when cut-off takes place at ¼-stroke for each 15 degrees of the circle. Size, 13 inches by 19 inches. Price, 25 cents.

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123 P. E. Liberty St., New York

Stop That Oil Waste With Unit Oil Filters

You know that by dripping anywhere from 50 to 90 per cent. of oil is being wasted every year. If you will gather and cause it to pass through the "Unit," you will have clean oil and this waste may be used over and over again.

One "Unit" works just as efficiently as a number and has a capacity of from 200 to 250 gallons every 24 hours, so as the plant increases, additional "Units" may be added.

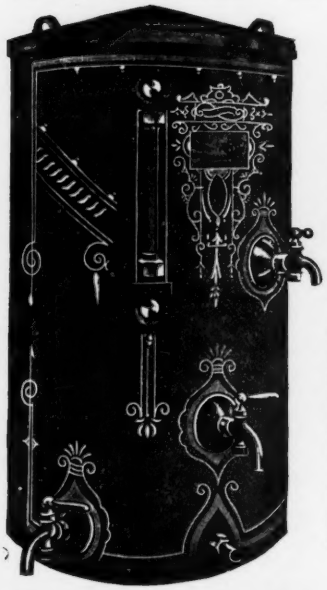
Our new 64-page Catalogue is the most handsome ever issued by any oil filter concern and fully describes the "Cross, American, Warden and Unit" Oil Filters, the "Burt and Standard" Exhaust Heads and the "Burt" Ventilator. A copy awaits your address.

The Burt Ventilator

Sectional view glass top, showing sliding sleeve damper (patented)

brings daylight and pure air to the engine room. It will remove hot air, smoke, steam, etc. without lowering the temperature too far for comfort. Our sliding sleeve damper has no flat surface to collect dust and refuse, it always remains in one position, unaffected by air currents, and when closed is absolutely stormproof, yet does not affect the passage of light. Used by the largest plants all over the country.

THE CROSS OIL FILTER MEANS



Money in Your Pocket

because it removes dirt and grit from your lubricating oil by straining it through waste, then washing it in pure, warm water. Requires practically no attention after starting, nor any great expense to maintain it—just a few cents per year for waste. Has nothing to break or get out of order and cannot clog.

Your Roof and Sidewalk Kept Clean By Burt Exhaust Head

It will positively remove water and oil from exhaust steam lines.

It contains no baffle plates, diaphragm or scrap metal.

Is built from extra heavy iron, lapped, riveted and soldered.

The Burt Mfg. Co. Largest Manufacturers of Oil Filters in the World. 204 Main Street, AKRON, OHIO, U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors

A fine large calendar for 1907 has just been issued by Revere Rubber Co., Boston, Mass. Those who want one should write immediately before the edition is exhausted. They will be mailed free to engineers who mention THE PRACTICAL ENGINEER.

The Snider-Hughes Co., of Cleveland, Ohio, and the Canton Pump Company, of Canton, have consolidated under the name of the Canton-Hughes Pump Company. The Snider-Hughes Company's plant has been moved to Canton, and the two united plants form one well-equipped factory, with facilities for an increased output of a very large line of high-grade Duplex and Single Pumps.

Mr. Thomas G. Keogh, 428 Park Row Building, New York, has accepted the agency for the Jacobs' patent feed-water heater and purifier, built by Chas. Jacobs & Co., 49 Oliver Street, Boston, Mass.

The Walsh Packing Co. have removed their offices and factory to 304 New Street, Philadelphia, where they have larger space and much better facilities. The new location is in the down-town business section and very convenient for shipping purposes and for quick delivery to either Philadelphia or out of town trade.

Black Hawk packing, made by Revere Rubber Co., Boston, Mass., is a high-grade red, sheet-coated on both sides with graphite, which is intended to facilitate the frequent breaking of joints without destroying the packing. Cut or moulded gaskets are made of the same material and are claimed to be very durable. A catalog describing "Black Hawk" and several other interesting rubber specialties will be mailed to any one mentioning THE PRACTICAL ENGINEER.

A wealth of interesting data and information on the subpect of air compressor and air drill lubrication is presented in a twenty-four page pamphlet, which is sent free of charge to all who are interested in the subject by Joseph Dixon Crucible Co., Jersey City, N. J.

The Cleveland Office of the Crandall Packing Co. has been moved from 9 South Water St. to 805 Superior St., N. W., in the Wade Building.

The Ohio Injector Co., Wadsworth, Ohio, are distributing their new supply of leather-bound memorandum books for 1907, which contain useful information for engineers, also map of the United States and its possessions, rules and tables for calculation and blank pages for memoranda. To cover cost of books and postage these books are distributed when application is accompanied by 25 cents in stamps.

The Western Electric Co. have published a new catalog describing their Hawthorne Works. It contains 24 pages, size 7 inches x 10 inches, and shows several very good illustrations of their shops, together with some photographs of generators and complete plants. A copy will no doubt be sent free to any one interested. Address Western Electric Co., 11th and York Streets, Philadelphia.

Mr. W. E. S. Dyer, formerly manager of the Reeves Engine Co., Philadelphia, Pa., has been appointed manager of the Philadelphia Office of the A. D. Granger Co., Commonwealth Building, Philadelphia, Pa. With his new connection Mr. Dyer will handle not only the vertical automatic engines built by the Bates Machine Co., of Joliet, Ill., but the Skinner Automatic Engines and a full line of fire and water tube boilers which the A. D. Granger Co. manufactures.

Mr. Warren A. Peters will remain at the Philadelphia Office with Mr. Dyer.

Photographs of some very large heater installations running as high as 10,000 H. P. are shown in the catalog describing the Pittsburgh Feed Water Heaters and Purifiers issued by James Bonar & Co., 716 Frick Building, Pittsburgh, Pa.

The Graphoil Steam Cylinder Graphite Cup is a new device for feeding graphite into the cylinder with oil. Its action is automatic; the oil passing over and taking up the surface of the graphite on its way to the cylinder, thus insuring approximately an equal proportion of graphite to oil at all times. It is manufactured by Comstock Engine Co., 59 Clymer Street, Brooklyn, N. Y. A pamphlet describing its advantages in detail and showing its construction and operation will be mailed to any one interested.

A pamphlet describing the Burt Ventilator and giving a table of sizes, capacities, weights, prices and other useful pointers about this particular ventilator, has just been received from the Burt Mfg. Co., 204 Main Street, Akron, Ohio.

Department "F" of the American Steam Gauge & Valve Mfg. Co., 208 Camden Street, Boston, Mass., have some interesting printed matter describing the American Thompson Indicator and their patent detent motion; which they will mail to any of our readers upon request.

"Boiler Scale and Its Removal" is the title of a new booklet issued by the Lagonda Mfg. Co., Springfield, Ohio. Send for a copy if you are interested in this subject.

For steam, vacuum or recording gauges of any kind; pop-safety valves, relief valves, or blow-off valves, the Ashton catalog will be found a valuable collection of data and information. Address Ashton Valve Co., 269 Franklin Street, Boston, Mass.

This month the Geo. W. Lord Co., are offering a Jelco gauge glass cutter free for a sample of scale. See their advertisement on page 36-37.

One of the advantages of the New England Roller Grates is that they do not change their opening when you shake them. No matter how vigorously you agitate them the opening always remains the same so that the coal cannot drop through, though the shaking quickly removes the ash. It rests on rollers and is therefore easy to shake. A catalog giving detailed description with prices and full particulars will be mailed to any engineer or power plant owner upon request by the New England Roller Grate Co., 310 Main Street, Springfield, Mass.

Willoughby's patent improved shaking grates are interestingly described and illustrated in a new catalog just issued by Alfred B. Willoughby, The Bourse, Philadelphia.

A sixty-page booklet just issued by the American District Steam Co., of Lockport, N. Y., is an interesting treatise on the subject of district steam heating. It shows how many a power plant may be made profitable by furnishing steam heat to the district, or to a few immediate neighbors. This is a subject that engineers will do well to study. A copy of the booklet will be mailed to any engineer or power plant owner.

Mr. Fred. L. Lane, of Indian Orchard, Mass., who was connected with the Chapman Valve Co., as superintendent and in other capacities for thirty years, is now manager and superintendent of the new Monarch Valve Co., of Warren, Mass. Mr. Lane has a wide reputation as a valve expert and the new company is fortunate to secure him. Other Indian Orchard men who have gone with the Monarch Co. are M. J. Meeker, A. F. Winton, R. H. Powell and O. E. Hines. One of the special features of the Monarch Valve is the loose neck arrangement which relieves strains and assists in obtaining a perfect seat. It also allows the changing from right to left or vice versa, and the renewal of parts without disconnecting. The Monarch is of the gate type with solid seat and solid wedge-shaped plug. The Monarch Co. is incorporated under the laws of Massachusetts with a capital stock of $75,000. The officers are: President, Chas. J. Roadstrand; Vice-President, J. W. Superneaw; Treasurer, Stewart M. Robson.

Mr. M. R. Porter has been appointed sales manager for the Pittsburgh Gauge and Supply Co., of Pittsburgh.

The advertisement of the Nason Mfg. Co. in this issue is intended to give users of this popular trap a clear understanding of the range in sizes of their "Class B" and "Class C" traps.

The Ashton Valve Co., 271 Franklin Street, Boston, Mass., have issued a handsome new calendar for 1907, copies of which will be sent to any one sending them 10 cents to cover cost of wrapping and mailing.

For every dollar that a power user saves by the use of cheap lubricants it is fair to say that he pays ten dollars out for fuel and repairs, which could have been saved by using the best oils and greases. Indeed, but few engineers realize the damage that may be done to fine machinery; especially engine valves and cylinders by the use of inferior lubricants. The A. W. Harris Oil Co., 320 South Water Street, Providence, R. I., have built up an enormous demand for Harris Oil, practically all of which is the result of their long and careful study of the science of lubrication, enabling them to produce a highly refined line of lubricating oils, which are probably not excelled anywhere on the globe. Their complete line of oils, together with a vast amount of good information, can be found in their catalog. Those who have not a copy write for one; its worth having.

CAUTION

The Success and POPULARITY of the **American Thompson Improved Indicator,** like everything else that succeeds, has excited the envy of IMITATORS, and the market is flooded with CHEAP SUBSTITUTES of our valuable instrument, patented by J. W. Thompson and manufactured solely by us. The imitations are manufactured to sell on price and in no case are to be compared with the Original and Genuine

Order by the name
" AMERICAN "
and get the genuine.
There is but one and
we make it.
ADDRESS DEPT. F.

American Thompson Improved Indicator

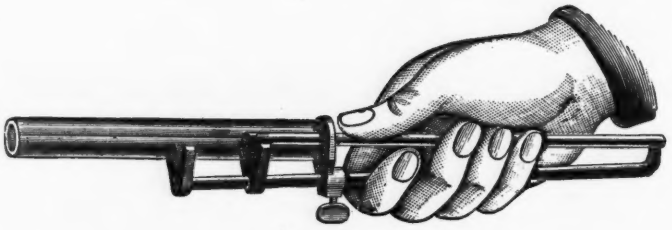
With the New Improved Detent Motion

American Steam Gauge & Valve Mfg. Co.

No. 208 to 220 Camden Street

NEWYORK SAN FRANCISCO **BOSTON, MASS.** ATLANTA CHICAGO

LORD



The (Jelco) Gauge Glass Cutter sells for $1.50. We have ordered a lot and you may have one of them FREE.

This Cutter is a valuable tool and will be sent all charges paid if you will send us

Lord's Water Purif

THE GEO. W. LO

2238-50 North Ninth Street,

The
Geo. W. Lord Co.
2238—50 N. Ninth Street
Philadelphia, Pa.

COUPON No. 1

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyse it, send me certificate of analysis and a Jelco Gauge Glass Cutter free of charge.

Number of boilers in use.....
Capacity of each boiler.....
Frequency of cleaning boilers.....
Frequency of opening the blow-off during working hours.....
River or other source of water supply.....
.....
Boilers are used about.....hours out of 24.
Boiler compound now used .....
Coal burned per day.....
Name.....
Street and No.....
City.....State.....
Firm's Name.....

Practical Engineer

RD'S

sample of scale from TWO steam plants with the TWO coupons attached.

These samples must come from TWO plants for which we have made no analysis previously.

Engraved certificates of analysis will be sent, also some information about our method of preparing chemicals for use in steam boilers

urifying Chemicals

LORD COMPANY

eet, - - Philadelphia, Pa.

COPONU No. 2

The
Geo. W.
Lord Co.
2238–50
N. Ninth Street
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyse it, send me certificate of analysis and a Jelco Gauge Glass Cutter free of charge.

Number of boilers in use.....
Capacity of each boiler.....
Frequency of cleaning boilers.....
Frequency of opening the blow-off during working hours.....
River or other source of water supply.....
Boilers are used about.....hours out of 24.
Boiler com pound now used.....
Coal burned per day.....
Name.....
Street and No.....
City.....State.....
Firm's Name.....
Practical Engineer

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IT SHOULD BE IMPORTANT TO ENGINEERS AND STEAM USERS

to know that the formulas of

WARLEY'S BOILER CLEANSING COMPOUNDS

are founded on sound chemical principles, and that only the purest grades of chemicals obtainable, regardless of cost, are used in the preparation of these goods, which have now been on the market throughout the United States and Canada, and in many other foreign countries as well, for a great many years, and they are now well and favorably known to thousands of Engineers and Steam Users as Boiler Cleansing Compounds that positively remove incrustation or scale and prevent corrosion and pitting in steam boilers, without doing any injury to the boilers, or their fittings, or to any goods in course of manufacture while using the live steam from the boilers with these Compounds in use therein.

These Compounds are varied to suit the individual needs of steam users, and the grade required can be determined when we are furnished with a small piece of scale from the boiler in which the Compound is to be used, a piece weighing about two ounces will be large enough for our purpose.

Send for Blue Book "Questions and Answers for Engineers, etc.," which we will mail to any Engineer, free, who is in charge of a steam boiler, and who will give us the name and address of firm by whom employed and send us a small piece of scale from his boiler, also mention this paper. Address :—

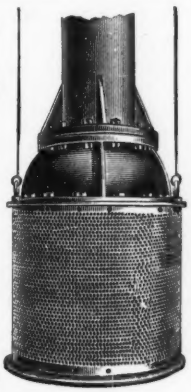
No. 221 South Front Street **THOS. C. WARLEY & CO.** **PHILADELPHIA, PA.**

We also carry a full line of High Grade LUBRICATING OILS and GREASES. A trial order solicited.

The Continuous Service

Foot Valve

Water can be taken continuously and without interruption from streams and ponds that are full of leaves, twigs, fish, sticks, paper and other refuse.



Outer Screen resting on bottom plate

NO STOPPAGE FOR CLEANING

The outer screen is raised by ropes or chains for cleaning.

Outer Screen Drawn part way up on suction pipe

When outer screen is lowered into position the knives at top and bottom scrape the outer surface of the inner screen and clean it.

The suction pipe extends to within a few inches of the bottom plate of valve, thus permitting of successful operation in shallow water.

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The

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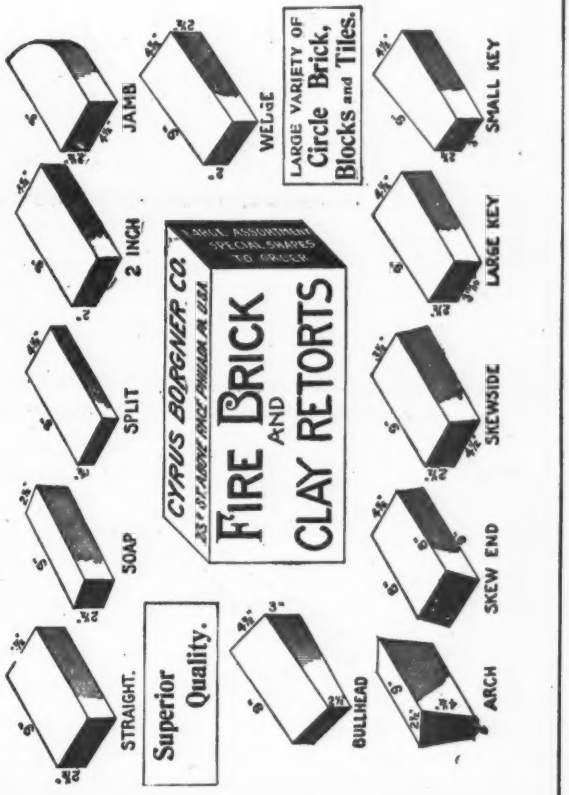
26 Cortland St., New York



Every Engineer

desires to operate his plant with the utmost practicable economy.

Every Employer

is anxious to keep the expense account just as low as possible.

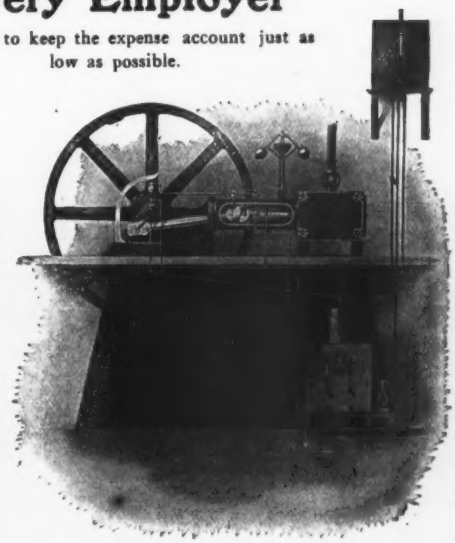
In a power plant where the

White Star Continuous Oiling System

is in use, the saving of oil is astonishing from the start and and becomes fairly astounding as the weekly items pass into the monthly totals, and the monthly totals mount into yearly aggregates showing

REDUCTIONS OF FULLY ONE-HALF

The savings begin with the first minute the system is in operation. We have been collecting facts and figures on the subject which we will be pleased to send, together with booklet "F" which illustrates and describes our method of perfect and economical lubrication of engine bearings. Send for it.



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JERSEY CITY, N. J.

GRANDPA

used to drive oxen. Today it is automobiles. Yet some of us are still transmitting power as Grandpa did.

Ever hear of Leviathan? And you have never investigated it? This is the address to write to.

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Tudor Manufacturing Co.
Worcester, Mass, U. S. A.

We make nothing but quick acting tools that make the mechanic valuable to the man who hires him.

Steam Fitting

If not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN

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Bell-Walnut 1271a. Keystone-Main 1-71.

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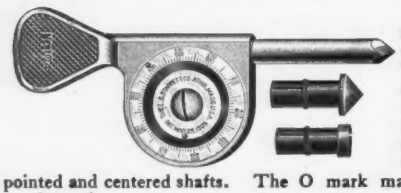
Speed Indicator No. 104

Price, Postpaid, $1.00



This Indicator may be run at highest speed required, without heating. The working parts are encased. Dial has two rows of figures, reading either right or left as shaft may run. Steel pointed spindle with rubber tips for both pointed and centered shafts. The O mark may be instantly set at the starting point.

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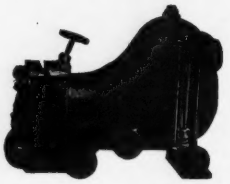
THE L. S. STARRETT CO., ATHOL MASS. ,U. S. A.

McDANIEL Improved Steam Trap



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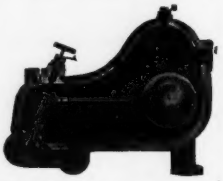

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cannot be equaled anywhere, disk is not only regrinding and reversible but is also renewable decidely economical because it will outwear three to five other makes.

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The liquid flows from receptacle to drip pipe, while nothing but **dry steam** escapes.

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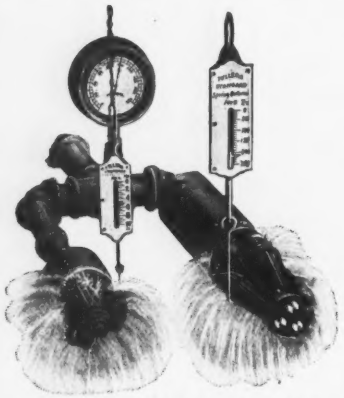

The "DEMON" on the right of photo showing over 40 times the pulling power of the Turbine on the left. Pump pressure 100 lbs.

For years before the invention of the "Demon" the engineer in charge of water tube boilers had to content himself with small inefficient cleaners weak in operation and construction. There was no real and positive force about them. Should the machine be urged forward a little it would provokingly come to a dead stop. The operator must tiresomely pull and jerk the cleaner backward and forward, exhausting patience and strength as well.

The power of a turbine cleaner is small because the wheel is located crosswise of the tube and is therefore smaller than, and limited by the diameter of the tube.

The power of the "Demon" is great because its pistons are located lengthwise of the tube and the area that the water pressure acts on is not limited by the diameter but by the length of the tube.

A LARGE PISTON AREA MEANS POWER.

The result is that the "Demon" is many times the most powerful water tube cleaner ever seen and is even guaranteed to clean perfectly tubes absolutely closed with scale.

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Because it is simple and durable—has but one working part.

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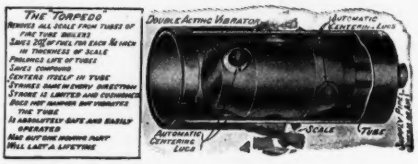

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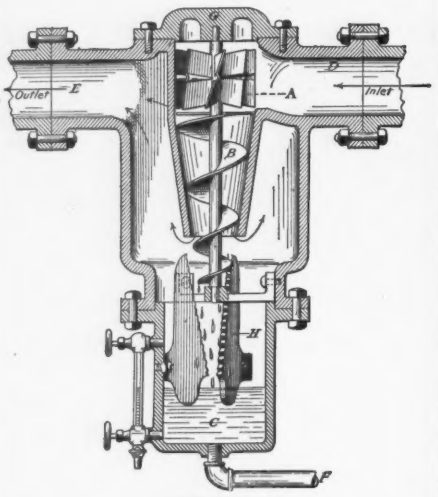

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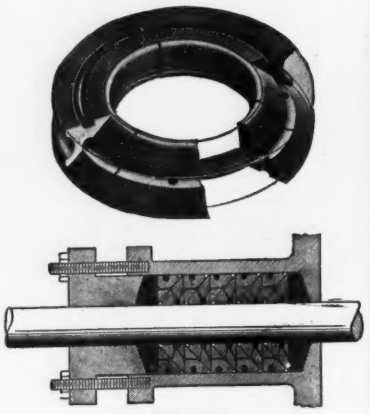

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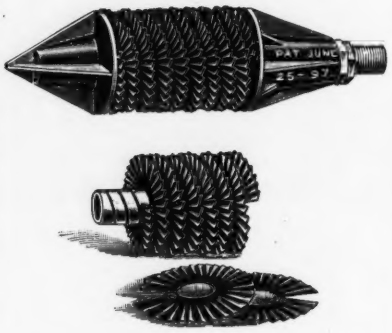

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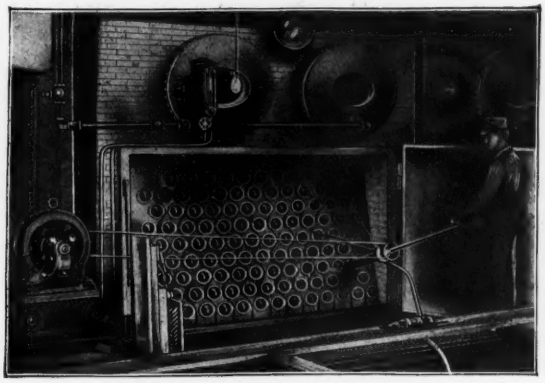

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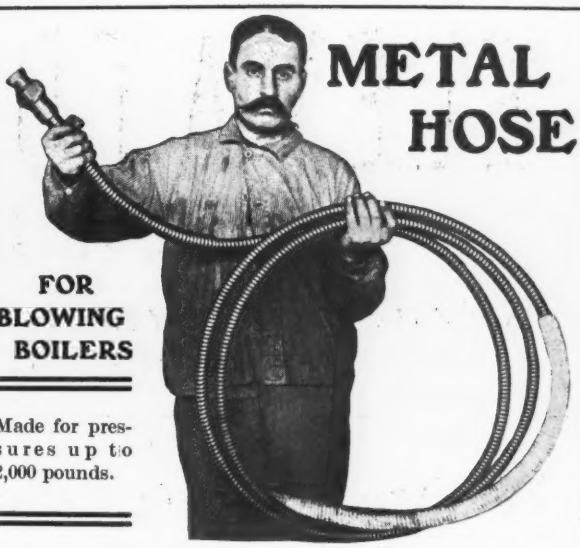

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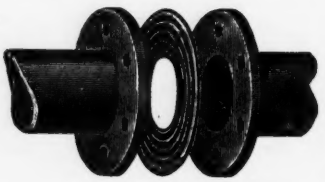
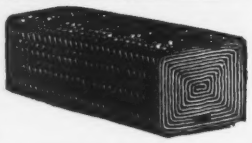


METAL TO METAL



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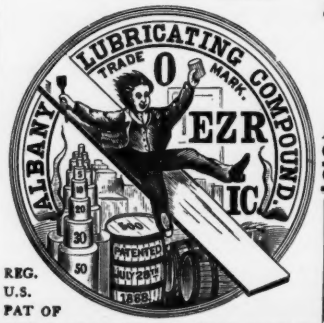

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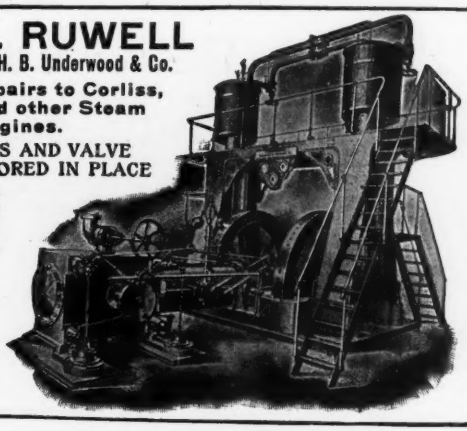

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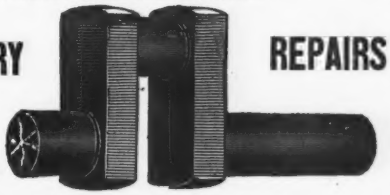

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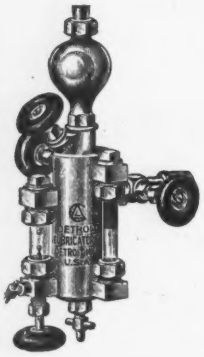

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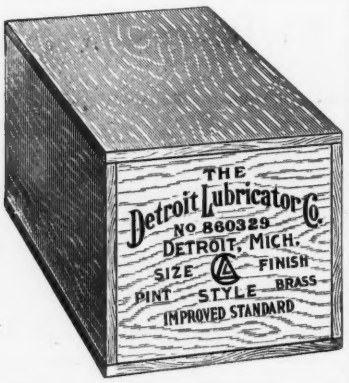

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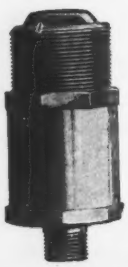

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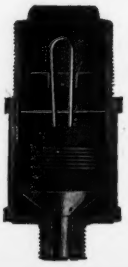

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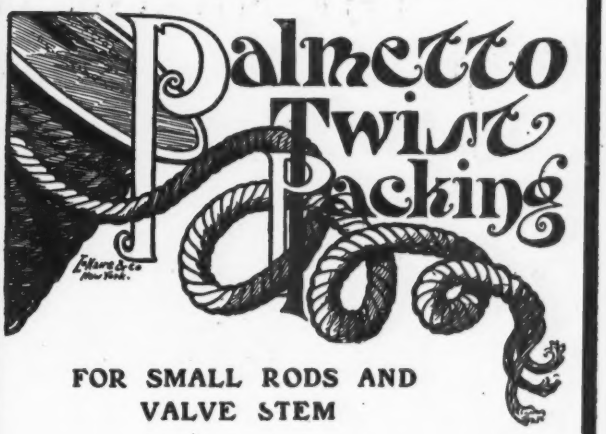

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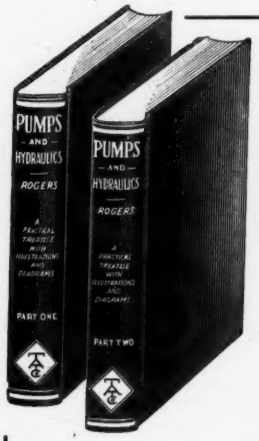

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Kellam Damper Regulators

THE SIMPLEST AND CLOSEST DAMPER REGULATOR

Manufactured by

J. E. LONERGAN & CO.

211 RACE ST., - PHILA, PA.

Brass Founders and Finishers and Makers of Pop Safety Valves, Water Relief Valves, Oil Cups and Lubricators, Steam Pressure Regulators and other Safety Steam Appliances.

Old Kellam Regulators Repaired.
Correspondence Solicited.
Mention this paper if your inquiry is prompted by the sight of this advertisement. Catalogue D free on application.

THE NASON MANUFACTURING COMPANY'S

"CLASS B", "CLASS C" and "SIDELUG" STEAM TRAPS
THE STANDARD OF THE WORLD

NASON TRAPS

E-50 NO. 1 "CLASS B." 1 to 20 lbs.
E-51 NO. 2 "CLASS B." 1 to 20 lbs.
E-52 NO. 3 "CLASS B." 1 to 20 lbs.
E-53 NO. 4 "CLASS B." 1 to 20 lbs.
E-54 NO. 5 "CLASS B." 1 to 20 lbs.

E-55 NO. 1 "CLASS C." 20 to 70 lbs.
E-56 NO. 2 "CLASS C." 20 to 70 lbs.
E-57 NO. 3 "CLASS C." 20 to 70 lbs.
E-58 NO. 4 "CLASS C." 20 to 70 lbs.
E-59 NO. 5 "CLASS C." 20 to 70 lbs.

E-60 NO. 1 "SIDELUG." 40 to 150 lbs.
E-61 NO. 2 "SIDELUG." 40 to 150 lbs.
E-62 NO. 3 "SIDELUG." 40 to 150 lbs.
E-63 NO. 4 "SIDELUG." 40 to 150 lbs.
E-64 NO. 5 "SIDELUG." 40 to 150 lbs.

"Class B," "Class C" and "Sidelug" Steam Traps.

No	1	2	3	4	5
Size of Pipe Connections ..... inches	½	¾	1	1¼	1½
Diameter outside of Flanges ..... "	10¾	14¼	15¾	19	24¼
" of Cylinder ..... "	8	10½	12	14	18
Height to top of Valve ..... "	11	14	16¼	18½	23½
" " Cover ..... "	8	10	12	14	15½
Nominal discharge lbs. water per minute ..	2	5	8	12	20
" Square feet of surface	350	900	1400	2000	3500
" Lineal feet of 1-inch pipe	1050	2700	4200	6000	10500
Weight, "Class B" and "Class C" ..... lbs.	40	80	113	176	336
" "Sidelug" ..... "	47	92	125	212	343
Each, "Class B"	16.00	20.00	27.50	42.50	70.00
Code Word, "Class B"	Bevel	Battle	Biter	Braket	Bruno
Each, "Class C"	16.00	20.00	27.50	42.50	70.00
Code Word, "Class C"	Neva	Nina	Nordau	Nolly	Novice
Each, "Sidelug"	16.85	21.30	29.25	45.50	74.75
Code Word, "Sidelug"	Stellar	Starry	Stamen	Stiple	Story

THE GENUINE NASON TRAPS ALWAYS HAVE OUR NAME ON THE COVER
THEY ARE GUARANTEED UNCONDITIONALLY
SPECIAL CATALOG

Nason Manufacturing Company
ENGINEERING SPECIALTIES
71 BEEKMAN STREET **NEW YORK** 71 FULTON STREET

The Ashton Quality

POP SAFETY VALVES
RELIEF VALVES
BLOW-OFF VALVES

can be trusted at all times, being of a superior quality and guaranteed to give perfect satisfaction.

Send for catalog "D"

THE ASHTON VALVE CO.
271 Franklin St.
Boston, Mass.

STEAM AND VACUUM GAGES
RECORDING GAGES

are absolutely accurate and reliable, having non-corrosive movements.

BRANCH STORES
110 Liberty St., New York
142 N. 6th St., Phila., Pa.
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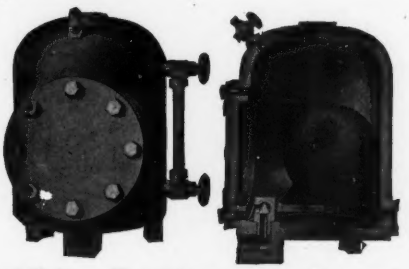
PRACTICAL
Ammonia Refrigeration
By REDWOOD

is a Practical Handbook for Engineers in charge of Ice Plants. It contains 146 pages of good reliable information including numerous Tables and is fully illustrated.
The Tables alone are worth the price of the book for reference purposes. Price, $1.00 or will be **sent free** as a premium for a Club of Three Subscribers to The Practical Engineer at Fifty Cents Each.
One Subscription to The Practical Engineer and a Copy of this Book for One Dollar.

ADDRESS THE PRACTICAL ENGINEER
46 North Twelfth Street, PHILADELPHIA, PA.

WHAT DO THE WORDS
Steam Trap Mean?

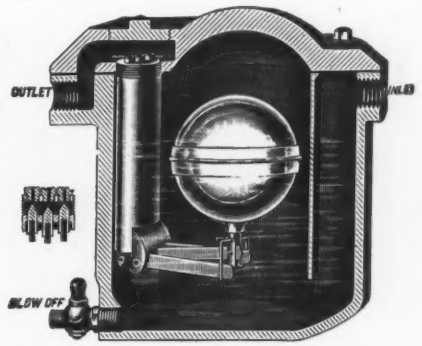
Does it mean that the steam and condensation should both be traped, or does it mean to discharge both the condensation and the steam? **No! It means to discharge the condensation and trap the steam.** That is just what the **Lindstrom's Corliss Valve Steam Trap does.** It never wastes any steam and is sure to remove all the condensation, no matter how much there is, as it is the greatest Emergency Trap on the market, and further-more it is impossible for any scale or other impurities to get between the Valve and the Seat, which is always tight and reliable.



A trial of 30 days will convince you that Lindstrom's Trap is worthy of its name.

A Catalogue which also includes Corliss Engine Valve setting accompanied by diagrams and tables is sent free.

MANUFACTURED BY
JOHN T. LINDSTROM
214-216 S. Third Street, Allentown Penna.
PHILADELPHIA AGENTS
AMERICAN BOILER ECONOMY CO., 420 Mutual Life Bldg., Philadelphia



THE WRIGHT "EMERGENCY"
HIGH PRESSURE
STEAM TRAP

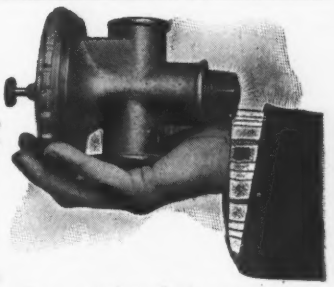
THREE VALVES — THREE TRAPS IN ONE
WATER SEAL PREVENTS STEAM WASTE

Discharges Instantaneously and Automatically all Accumulated Condensation in Steam Pipes, Etc.

SEND FOR CATALOG

Wright Manufacturing Co.
DETROIT, MICH. 72 WOODBRIDGE STREET

You not only
Get Your Money's Worth
but you
GET YOUR MONEY BACK
This is the kind of a Guarantee we place upon each sale of the

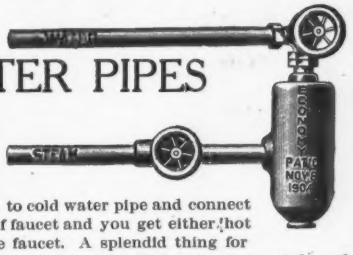


Dunham Steam Traps

Absolute Satisfaction must be obtained from their use or they are returned at our expense.

C. A. DUNHAM CO., Marshalltown, Iowa
Branch Offices:—Chicago, Cleveland, Philadelphia, Toronto
Resident Manager, L. BANCROFT MELLOR
No. 14 S. Fourth Street, Philadelphia, Pa.

HOT WATER, FROM THE COLD WATER PIPES



The Economy Faucet will give you an abundance of hot water instantly in any part of your plant. No tanks or hot water pipes are required. Just attach it to cold water pipe and connect a small steam pipe to side of faucet and you get either hot or cold water from the same faucet. A splendid thing for "washing up" or for any purpose for which hot water is wanted—and very cheap. Let us send you one on trial.

Economy Faucet Co., 97 Weybosset Street PROVIDENCE, R. I.

H. B. UNDERWOOD & Co.

MORRIS G. CONDON
ALBERT D. PEDRICK
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GENERAL MACHINISTS,

SOLE MAKERS OF
ST. JOHN SELF-ADJUSTING
CYLINDER PACKING

1025 HAMILTON STREET PHILADELPHIA, PA.

Repairs to Steam Engines, Steam Pumps and other Power Plant Equipment is our Specialty.

If your engine or pump breaks down, day or night, no matter what the conditions are, or where you are located, send for us. We have the largest force of expert mechanics and the largest assortment of special repair tools and machinery to be found anywhere in North America. We send the men and the tools and the machines direct to the job. You don't need to dismantle your heavy engines and pumps, we do the work on the spot.

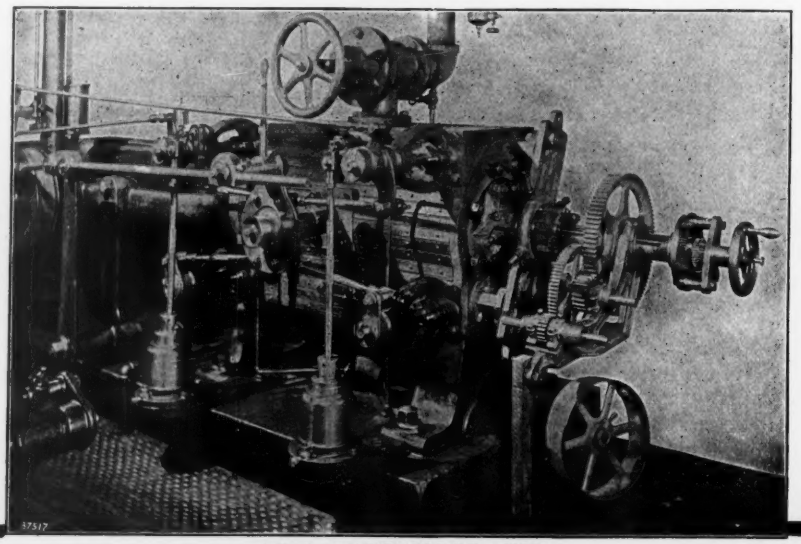
But don't wait until your engine breaks down. An ounce of prevention is better than a pound of cure, let us keep your plant in repair all the time, the saving in fuel will more than pay you. We rebore cylinders of any size in position and we have a special machine for reseating valves in position.

SOME OF OUR OTHER SPECIALTIES

Gear Cutting, Internal and External.
Ice Machine Repairs a Specialty.
Sole Agents for St. John Self-Adjusting Cylinder Packing.
Crank-Shaft Journals of all sizes turned off without removal.
Send for our Book of Useful Hints for Engineers.

Dynamo Commutators Turned Off Without Removal.
Builders of Dash Pots.
Portable Planer for Facing Off all Sizes of Hammer Blocks in position. All kinds of Steam Hammer Repairs.
Blacksmithing. Steam Power Hammer.

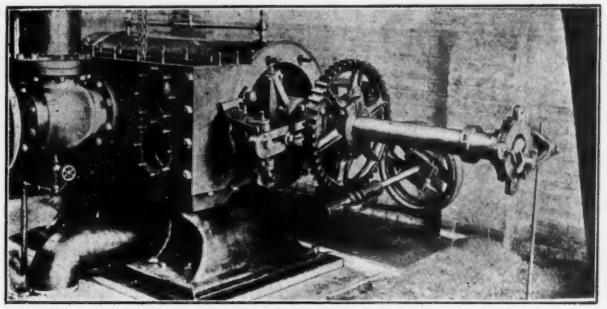
SEND FOR US



SEND FOR US

THE UNDERWOOD WAY

Engine Repairs

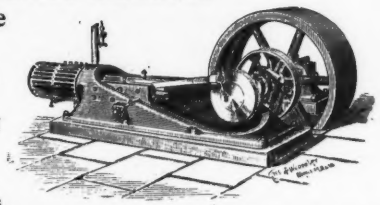


LEES' (PATENTED) IMPROVED PORTABLE BORING TOOL IN POSITION.

With Our Improved Methods and Tools we can repair your engine withou removing from foundation and Save Hours of Shut-Down

ENGINES ADJUSTED

Hartford Engine Works
HARTFORD, CT.
Successors to
Hartford Engineering Company
Builders of the
IMPROVED HARTFORD BUCKEYE ENGINES



We have the drawings and patterns and keep a line of repairs finished and part finished on hand for

Hartford, Buckeye, and Woodruff & Beach Engines

LUBRON GREASE combines perfect lubricating qualities with an exceptionally high melting point. Indeed it is the finest quality lubricating grease made anywhere in the world. It contains no acid, gum, grit or other harmful qualities; nothing but pure lubricant, and its high melting point and unequalled wearing qualities prove its superiority. It will keep for years without becoming rancid, thats another proof of its purity. Made in several grades of hardness 0 to 3. Try one can of it.

LUBRON HYDRAULIC COMPOUND NO. 10

Try using Lubron Hydraulic Lubricating Compound in your elevator tanks or other hydraulic apparatus and you will immediately notice a wonderful improvement in the running. The compound mixes thoroughly with the water of the tanks, lubricating the pistons, cylinders and valves and keeping all parts touched by the water in perfect condition. Write for catalog and samples.

KNOWLTON PACKING CO.
14 L. Street, - - - South Boston, Mass.

The Smith Pipe Clamp

Stops The Leak Every Time

A complete set for every size of pipe in your plant will save many a dollar. Quickly applied while pressure is on the pipe WE GUARANTEE TO STOP THE LEAK. Steel or brass, all sizes, ¼-inch to 20-inch. No trouble to send further information.

W. CLIFFORD SMITH
138 N. SIXTH ST., PHILA., PA., U. S. A.

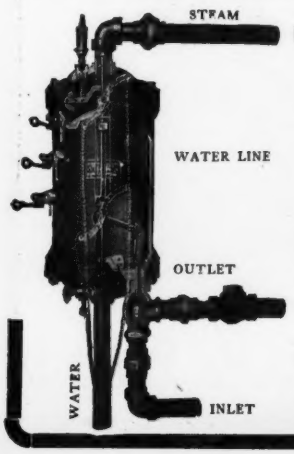
A Permanent Income

and steadily advancing values in the shares of this corporation is the result of the methods employed in conducting the business.

Shares selling now $1.25 each (par value $1.00).

Send for Booklet. You will be interested.

INDUSTRIAL ENGINEERING CO.
848 & 849 Drexel Bldg. Philadelphia, Pa.



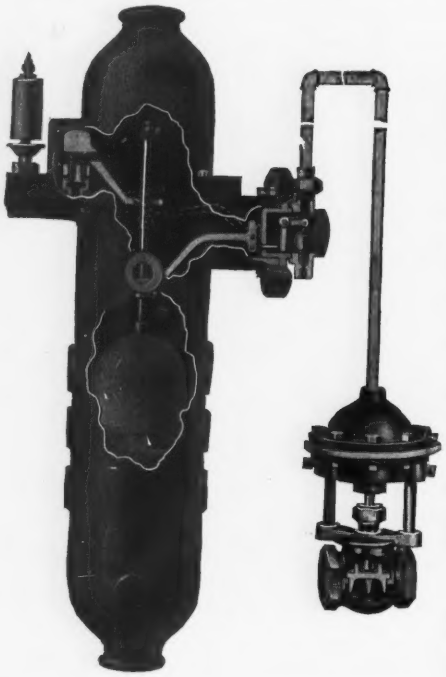
FEED-WATER Regulation is essential t. a well ordered plant. A water line which is fixed, and lived up to, means a saving in fuel, in boiler and engine wear and in condensation, because a uniform steam space in the boiler means drier steam.

The Burrows Feed-Water Regulator and Low Water Alarm

guarantees you a steady water level. It never fails to work. It was designed especially for batteries of boilers, one machine to each boiler directly controlling the water supply. Strongly and simply constructed, no stuffing box, no packing, no springs, and all internal parts are of brass. Can be installed as easily as an ordinary water column.

If you are endeavoring to cut down your fuel bills, prevent wear on your equipment and increase the efficiency of your plant generally, you will findyour end accomplished when you install a "Burrows." Catalog and free trial offer on request.

BURROWS MFG. CO., 73 Warren St., New York City



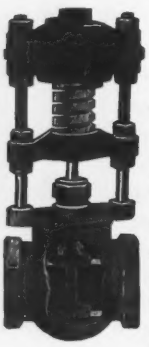
Doubtless you have met "engineers" who boasted that they could operate their boiler without a Safety Valve, and perhaps you have met other "engineers" who thought they could run their engine without a Governor. In years gone by there were many such, but the engineer of today knows better; he has learned the value of Automatic Regulation and the Economy of Automatic Protection.

There are still some who run their boilers without a Feed-Water Regulator but the day is fast approaching when this practice will be considered just as great an error as to omit the Safety Valve or the Governor.

A uniform water level means Safety and Economy from every stand point. It permits uniform firing. It protects the engine from slugs of water, and insures dry steam, which increases the efficiency of the whole system and saves repairs, and its the best insurance against boiler explosions.

Over eighty-five per cent of all Feed-Water Regulators in use in America are the Williams Safety Feed-Water Regulators.

WRITE FOR CATALOGUE

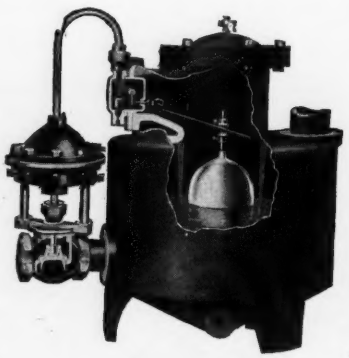


Williams Pump Governor

will appeal to the mechanical sense of any engineer at a glance, and it works just as good as it looks. It allows the water to run uniform, and operates in any position. It is made flanged or screwed and for any type of pump. It will operate under any condition on less than two pounds variation, will your governor do that?

Williams Trap

looks different from others, and so it is. It will keep your steam lines free of condensation. It has a quick acting valve operated by steam pressure. It blows the water out like a shot and closes just as quick. No wire drawing with this trap.

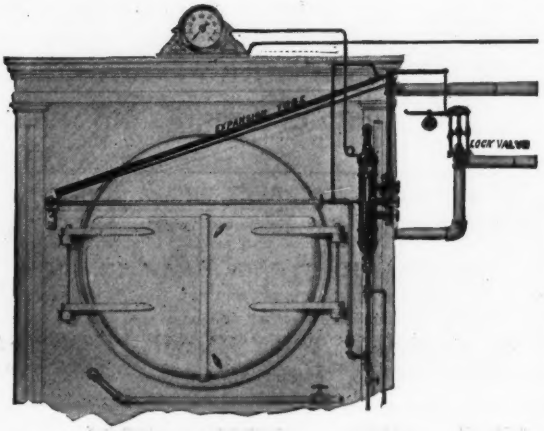


The Williams Gauge Co., Mount Oliver, P. O., Pa.

It is Governed by the Law of Contraction and Expansion

You Can't Beat Nature

In these days when everybody is installing Feed-Water Regulators on their boilers, you are naturally looking for one that will give perfect results and which will not get out of order. The best way to determine this is to look to its construction and operation.



Copes Feed-Water Regulator

is as simple as a bootjack. It is all on the outside of the boiler, where you can get at it. There are no Springs, Floats, Diaphragms or hidden part. Everything is open to your view and easily adjusted.

It works by contraction and expansion—you can't beat nature! It maintains a uniform water level that cannot vary a quarter of an inch from one year's end to the other. In use for ten years. Never has one of these Regulators failed to work. No other Regulator can show such a record, and none can show such low cost of repairs. The highest cost for repairing any COPES REGULATOR in the past ten years was $3.50. Most of them have not cost a cent.

WE INSTALL THEM ON FREE TRIAL.

LET US SEND YOU OUR CATALOGUE.

AMERICAN BOILER ECONOMY CO.

741 Mutual Life Bldg. Philadelphia, Pa.

Successor to WILFONG & WILTBANK

AGENTS FOR NEW ENGLAND STATES,

The New England Roller Grate Co., Whitney Bldg., Springfield, Mass.

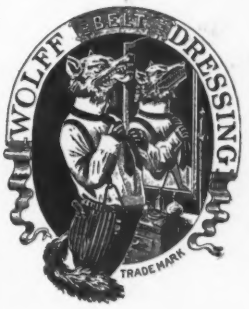
REPRESENTATIVE FOR MARYLAND AND DISTRICT OF COLUMBIA

John H. Walter, 1009 American Building

SAVE YOUR BELTS

BY USING

Wolff Dressing



IT CLEANS THE BELT. Prevents friction
Does not Gum up Belt or Pulleys.
Preserves the Leather—or Rubber.
Specially adapted to Loose Belts.
ALWAYS READY. NO Heating.
Goes further than any other. No waste.
The SAVING in Power and Preservation of the Belts exceeds its cost many times over.
It has been ADOPTED for this reason by the largest concerns in the country.

SATISFACTION GUARANTEED

In ordering specify whether for Leather or Rubber Belts

THE NORBERT WOLFF CO.

472 Greenwich Street New York, U. S. A.

"23"

That's what we do to troubles with

FEEDWATER

Also increase evaporation per pound of coal.

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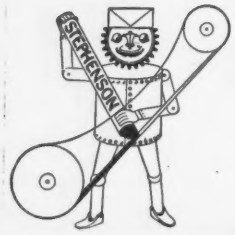
American Water Softener Co.

1002 Mutual Life Building

PHILADELPHIA, PA.

STEPHENSON

BAR BELT DRESSING



Trade Mark, Registered

Do you see in the picture how slack the upper part of the belt is? **STEPHENSON DRESSING** is doing the trick. No flickering light—**No wasted power** where **"Stephenson"** is used.

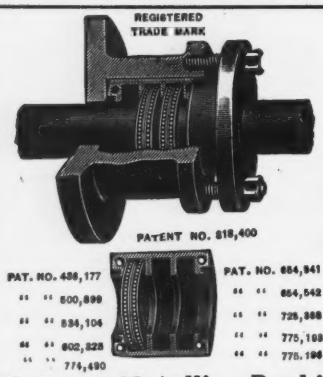
RED LABEL FOR LEATHER

GREEN LABEL FOR RUBBER OR CANVAS

NO **ONE** KIND IS G_OD FOR **ALL** BELTS

Your postal request to us gets a Free sample to you quick

Stephenson Manufacturing Co., Albany, N. Y.



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is now recognized as being superior to all others and is a common name among engineers

First cost, only cost.

Guaranteed 3 years. No Cutting. No Friction.

Less Oil.

Thirty Days Trial.

Send for Catalogue H.

Holmes Metallic Packing Co. WILKES-BARRE PENNA.

The United States Metallic Packing Co.

PHILADELPHIA AND CHICAGO

WE MAKE A SPECIALTY OF ALL KINDS OF

Hydraulic Repair Works

ENGINE AND STEAM PUMP REPAIRS

Special attention to erection of engines, boilers, pumps, Hot-Air Pumping Engines, etc. Our work the best and charges moderate.

PHILADELPHIA HYDRAULIC WORKS

1218 Cuthbert Street, PHILADELPHIA, PA

A Good New Year's Resolution :—

Where a Metallic Packing is needed, USE ONLY

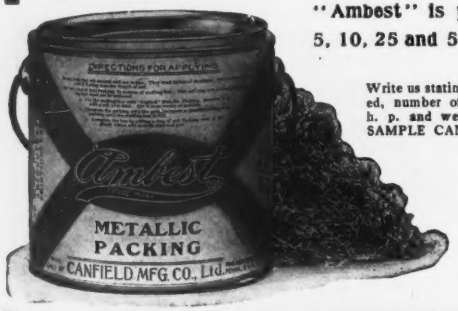
Ambest

TRADE MARK

the new and better packing at ½ the cost of others.

Fits any stuffing-box—has no rings or springs—stands any pressure or speed—easily or instantly applied—needs no replacing — wears for years — saves rods—stands 600 degrees farenheit.

"Ambest" is put up in 2, 5, 10, 25 and 50 pound cans



Write us stating by whom employed, number of engines and total h. p. and we will send you a SAMPLE CAN

Free

Will send name of our agent nearest to you upon request.

CANFIELD MANUFACTURING CO. Ltd.
116 Lehigh Ave., Philadelphia, Pa.

FREE

To Any Engineer

A TABOR CROSBY OR AMERICAN-THOMPSON

INDICATOR

Also 500 other things including every article, tool or device an engineer may want. For Free premium list and full particulars regarding this remarkable offer, fill out and mail us the coupon below.

FRANCE PACKING CO., Inc.
State Road, Tacony, Philadelphia
MANUFACTURERS OF
METALLIC, FIBROUS AND SHEET PACKINGS

Tear OFF Here

Date,_____1904.

FRANCE PACKING CO.,
State Rd., Tacony, Philad'a.

Gentlemen:

Kindly send me premium list and full particulars regarding the indicators and other articles you are giving to engineers.

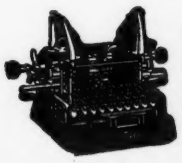
My name is_____

My address is_____

I am employed by_____

Give Complete Address.

YOU CAN EASILY OPERATE THIS TYPEWRITER YOURSELF



Don't worry your correspondent.

Don't write him anything by hand that akes him time to make out—that may leave him in doubt—that he can't easily read.

And don't fil out ega. papers or card memos—or make out accounts in your own handwriting.

It looks bad, reflects on your standing, makes people think you can't afford a stenographer, and is sometimes ambiguous.

You can write out your letters—make out an abstract—fill in an insurance policy—enter your card memos—make out your accounts, or a hotel menu—or do any kind of writing you need, on any kind, size or thickness of paper and space any way you wan on

The OLIVER Typewriter

The Standard Visible Writer

You can write any of these things yourself if you do not happen to have a stenographer.

For you can easily learn with a little practice, to write just as rapidly and as perfectly, as an expert operator on the OLIVER. Because the OLIVER is the simplified typewriter. And you can see every word you write. About 80 per cent. more durable than any other typewriter, because it has about 80 per cent. less wearing points than most other typewriters.

Eighty per cent. easier to write with than these other complicated, intricate machines that require "humoring"—technical knowledge—long practice and special skill to operate.

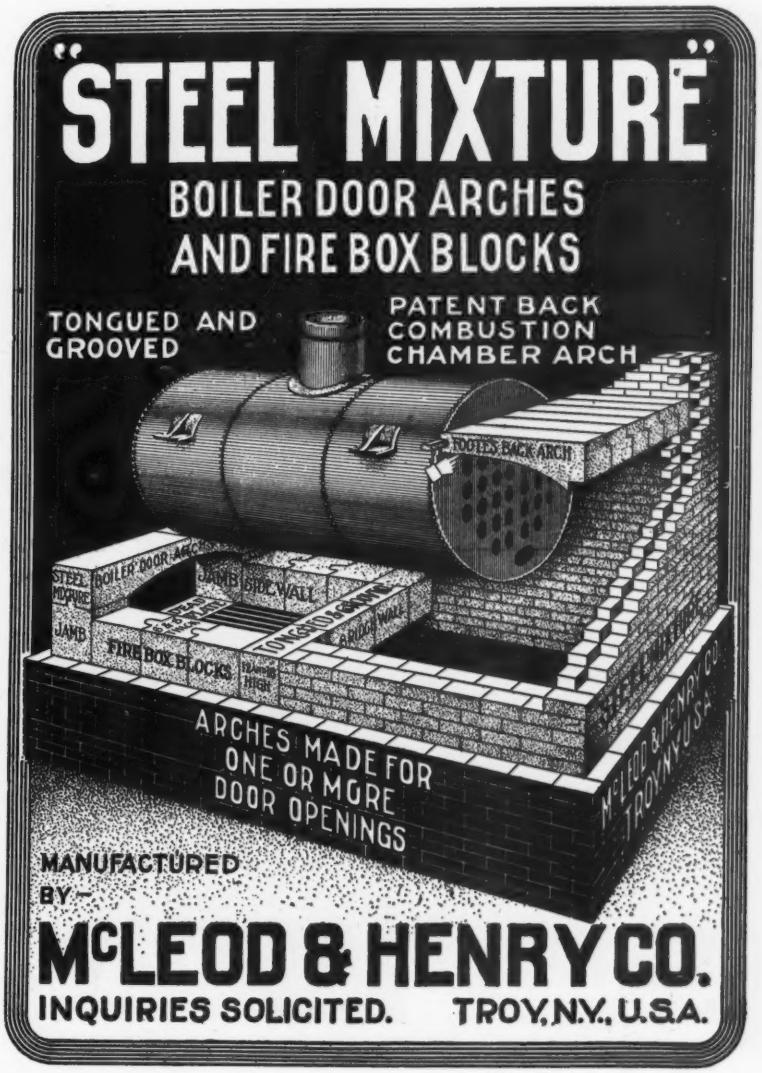
Than machines which cannot be adjusted to any special space—with which it is impossible to write abstracts, insurance policies, or odd-size documents except you buy expensive special attachments requiring experts to operate.

You can adjust the OLIVER to any reasonable space—you can write on any reasonable size and thickness of paper, right out to the very edge, without the aid of any expensive attachment or special skill, and your work will be neat appearing, legible and clear

Forth e OLIVER is the typewriter for the dector, the awyer, the insurance agent, the merchant, the hotel proprietor—or any man who does his own writing.

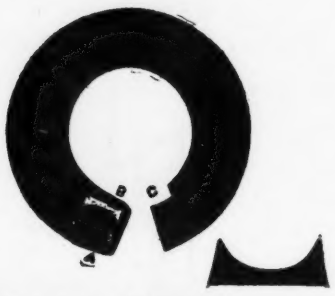
Write us now for our booklet on the simplified features of the OLIVER.

The OLIVER Typewriter Co.
WALNUT AND TENTH STS.
PHILADELPHIA, PA.


"STEEL MIXTURE"
BOILER DOOR ARCHES
AND FIRE BOX BLOCKS
TONGUED AND GROOVED
PATENT BACK COMBUSTION CHAMBER ARCH
ARCHES MADE FOR ONE OR MORE DOOR OPENINGS
MANUFACTURED BY—
McLEOD & HENRY CO.
INQUIRIES SOLICITED. TROY, N.Y., U.S.A.

BRANCH OFFICE:—
JOHN H. FOOTE, Manager
1402 BROADWAY—ROOM 1125—KNICKERBOCKER BUILDING—NEW YORK CITY

Walsh Metal Face Packing



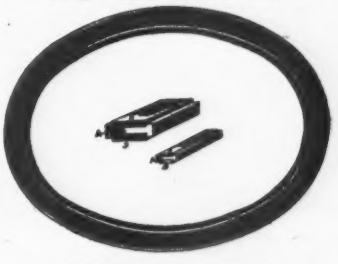
A—Fibrous Packing. B—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Walsh Combination Gaskets

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

PACKING FOR ELEVATORS a Specialty

WILL NOT BLOW OUT

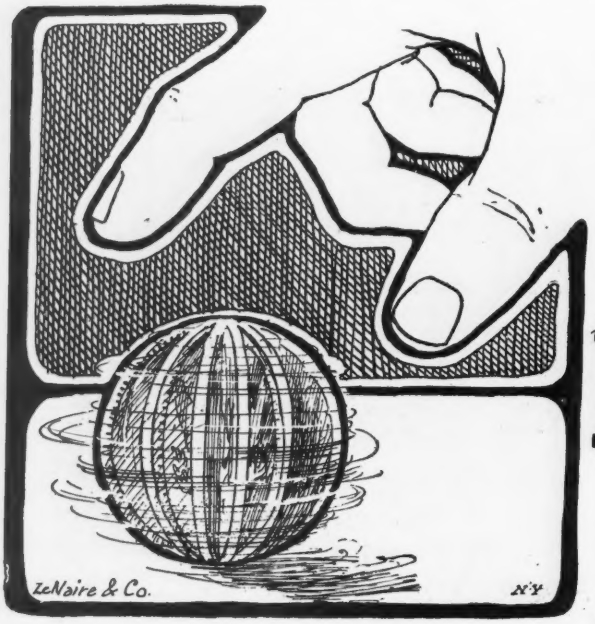


Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. BB—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets

Walsh Packing Co.

1118 and 1120 S. Seventh St., Philadelphia, Pa.



Buying a Packing without a reputation is like spinning a coin, on results, a hit-or-miss proposition —heads I win, tails you lose.

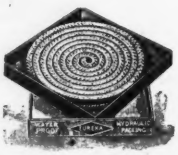
EUREKA PACKINGS

need small comment as far as reputation for quality, service, dependability, and economy goes. Select any-one of these six kinds that give promise to answer your purpose, and you stand upon solid grounds as far as saving time, trouble, expense and the keeping of rods limbered up—working free, yet steam tight, is concerned. Like everything else that's however good, there are imitations—then be careful to use the word "GENUINE" when ordering from your dealers EUREKA GUM CORE, EUREKA SHEET, EUREKA HIGH PRESSURE, EUREKA WATER PROOF, EUREKA SPIRAL, EUREKA SQUARE FLAX.

EUREKA PACKING CO.

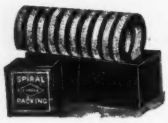
Sales Department JAS. L. ROBERTSON, Pres.

Eureka Gum Core

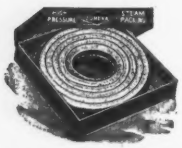


Eureka Water Proof

Eureka Sheet



Eureka Spiral



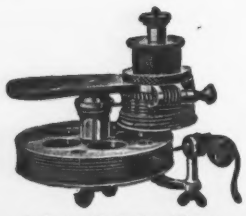
Eureka High Pressure

Eureka Square Flax

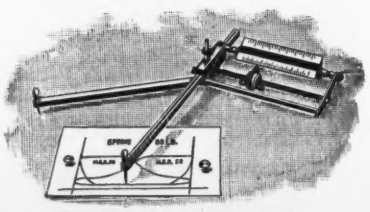
Your success as an engineer depends on what you know. No instrument will give you more knowledge and fit you for a place you could not otherwise occupy, than a Robertson-Thompson Indicator. It's price is right and terms of payment will be made right. There's a lot of trouble saved where a Willis Planimeter and Victor Reducing Wheel are used. Why not write today for prices and terms?

Jas. L. Robertson & Sons, Inc.

40 Warren Street New York



A Victor Reducing Wheel



The Willis Improved Planimeter

Robertson-Thompson Indicator

This Knife is Yours!

Its a beauty too—and Serviceable—the kind you admire

With your first order of 5 yards of

Vellumoid Packing

this handsome knife goes to you absolutely free. This is a generous offer—its more—its lavish! But we're determined to have you try Vellumoid in your engine or pump room. This is truly a remarkable packing. For high steam pressures—hot or cold oil—water—air—ammonia—gases—vibrating joints — expanding and contracting joints

For any Purpose use VELLUMOID PACKING

The way it HOLDS when other packings blow, rot or squeeze out—its tensile strength and non-solidifying qualities will prove a revelation to you. One of the largest machine shops in the country—a concern that has probably used all kinds of packings—tried Vellumoid. Their order for over a thousand yards followed. That's the way Vellumoid sells! Send us your order for 5 yards to-day—now! The supply of these handsome knives is limited and we don't want you to be disappointed.

J. H. PEARSON & CO.

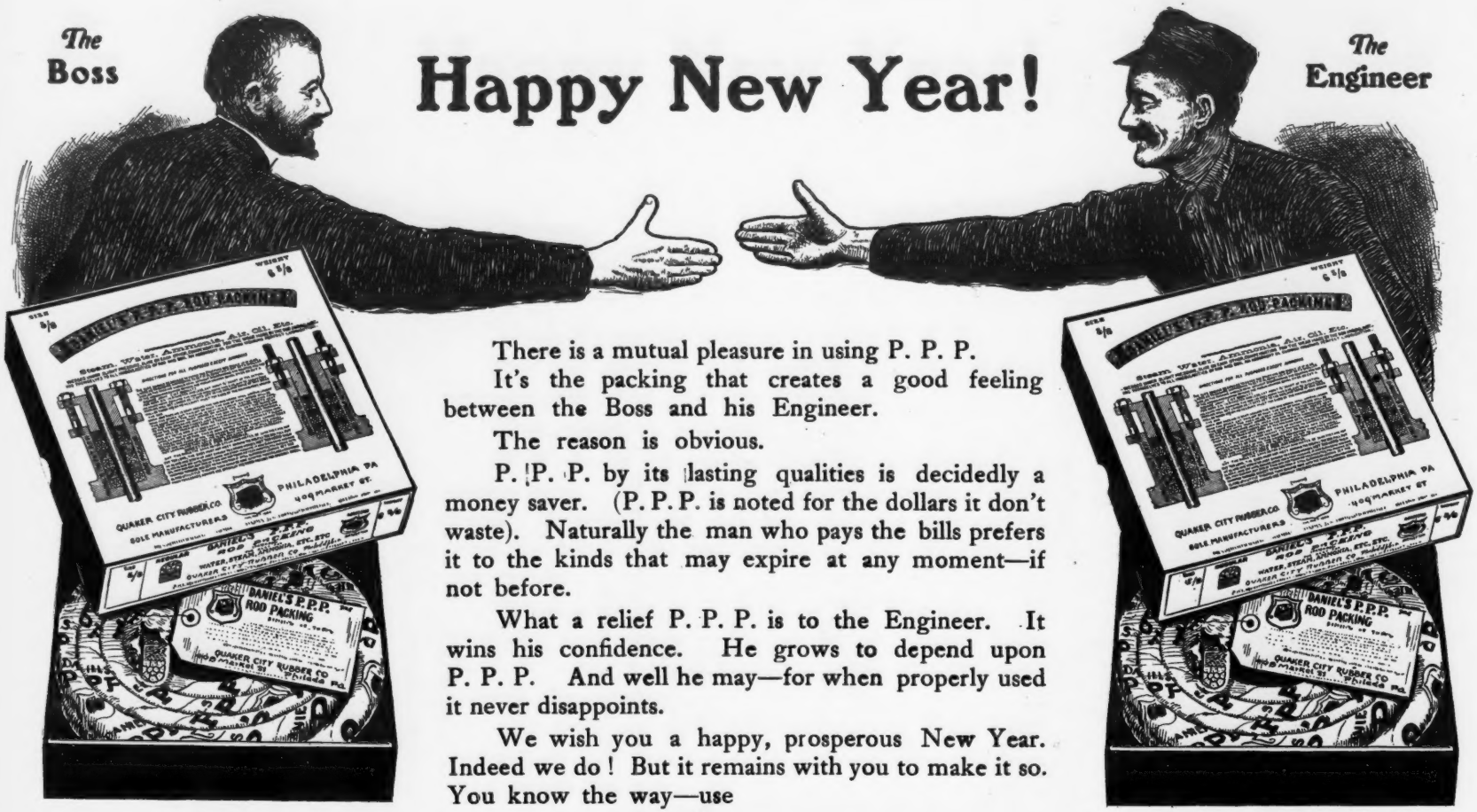
130 Centre Street New York

12 PEARL STREET, BOSTON, MASS.

The Boss

Happy New Year!

The Engineer



There is a mutual pleasure in using P. P. P.

It's the packing that creates a good feeling between the Boss and his Engineer.

The reason is obvious.

P. P. P. by its lasting qualities is decidedly a money saver. (P. P. P. is noted for the dollars it don't waste). Naturally the man who pays the bills prefers it to the kinds that may expire at any moment—if not before.

What a relief P. P. P. is to the Engineer. It wins his confidence. He grows to depend upon P. P. P. And well he may—for when properly used it never disappoints.

We wish you a happy, prosperous New Year. Indeed we do! But it remains with you to make it so. You know the way—use

P. P. P. ROD PACKING

QUAKER CITY RUBBER CO., Philadelphia–Chicago

If the joint leaks or blows out under high pressure, there is no

CENTURY
White Sheet Packing

in it—and if you put CENTURY WHITE SHEET PACKING in it, it will never leak nor blow out.
ASK YOUR SUPPLY HOUSE.

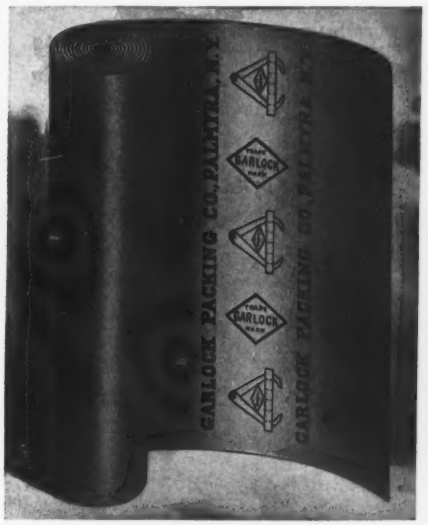
MANUFACTURED ONLY BY
PENNSYLVANIA RUBBER COMPANY
JEANNETTE, PA.

GARLOCK OIL PROOF
SHEET PACKING

THIS is a fine, high-grade Sheet Packing for high pressure steam. For pipe flanges that are affected by vibration it is the best packing made. It is unequalled for Gas, Naptha, Benzine, Tar or Syrup and positively **Oil** proof.

It makes either rough or smooth joints equally well, and perfectly tight when first applied. We make many other kinds of Sheet Packing for various uses, but we do not make any thing as good, nor does any one else make any packing that is as good as this for the specific uses mentioned above.

WRITE FOR OUR GENERAL CATALOG



STYLE No. 153

The GARLOCK PACKING CO.

Main Office:— Palmyra, N. Y., U. S. A.

FACTORIES
Palmyra, N. Y. Denver, Colo. San Francisco, Cal.
Atlanta, Ga. Hamburg, Germany New Orleans

STORES
Philadelphia St. Louis New York Atlanta, Ga.
Cleveland Denver Chicago Palmyra, N.Y. Pittsburg
San Francisco Boston Hamburg, Germany New Orleans

Black Hawk Packings

FOR SEVERE SERVICE

BLACK HAWK SHEET PACKING IS A HIGH GRADE RED SHEET, COATED ON BOTH SIDES WITH PLUMBAGO, WHICH PERMITS YOUR JOINTS BEING BROKEN REPEATEDLY

CUT OR MOULDED GASKETS FURNISHED ON SHORT NOTICE

WILL NOT HARDEN UNDER STEAM HEAT AND IS NOT AFFECTED BY AMMONIA.

A TRIAL WILL CONVINCE YOU.

FURNISHED WITH IRON OR BRASS WIRE INSERTION WHEN DESIRED

Try BLACK HAWK TUBULAR GASKETS

FOR LONG LIFE THEY HAVE NO EQUAL

FULL ILLUSTRATED PACKING CATALOGUE SENT FREE

WRITE FOR OUR LARGE CALENDER FOR 1907

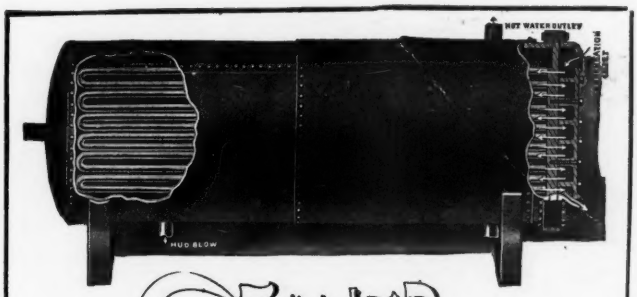
REVERE RUBBER CO.

FACTORIES
Chelsea, Mass.

HOME OFFICE
BOSTON, MASS.

BRANCHES:

NEW YORK	CHICAGO
PHILADELPHIA	MINNEAPOLIS
PITTSBURG	NEW ORLEANS
SAN FRANCISCO	PORTLAND, ORE.



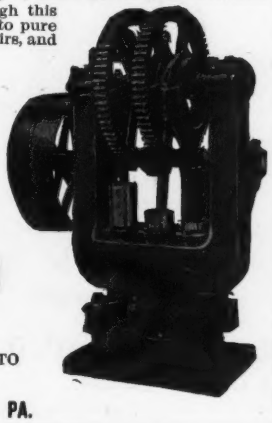
The CLEANER TRADE MARK

represents the Acme of Perfection in Feed-Water Heating, Condensations from Heating Systems, Paper Machines, Slashers, Dye Tubs, etc., are passed through this heater and made to impart their heat to pure water. It does away with traps, reservoirs, and separators at once.

Davis Triplex Power Pump

is unequalled for high pressure boiler feeding, and for all hard service.

also Manufacturers of the
"BERRYMAN" FEED-WATER
HEATER AND PURIFIER



I. B. DAVIS & SON
MAKERS
Hartford, Conn.
WRITE FOR CATALOGUE ETC., TO
THOS. McADOO
125 NORTH FOURTH STREET, PHILA, PA.

COCHRANE
SEPARATORS

Don't let people fool you on Separators.
IT'S TOO VITAL.

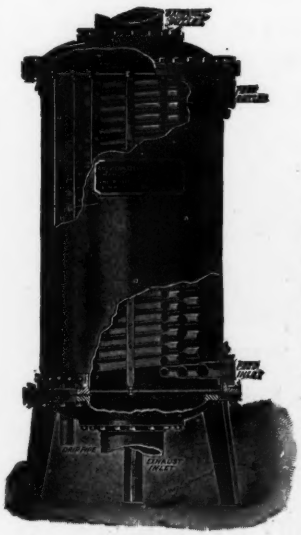
A Cochrane Oil Separator, for example, can easily make for you a hundred times its cost each year, and you have the satisfaction of knowing all the time that your boilers are receiving absolute protection from oil. That is, we positively guarantee to give you "OIL SATISFACTION."

Wish you knew as much about these "Cochranes" and the results they are giving as we do. We would have you down on our books as regular customers.

Our standard for making separators for oil service or for taking water out of steam is the one adopted by the largest steam users in the United States—the people who want things good and who are desirous of securing our expert advice in the installation of these appliances, for it stands to reason that after a fellow has built and helped to put in enough separators to equip more than 5,000,000 H. P. of plants he comes pretty near knowing how to do it right the first time, and there is a good deal in having things go right, RIGHT FROM THE START.

HARRISON SAFETY BOILER WORKS
3144 North 17th Street, Philadelphia, Pa.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

THAT.S THE KIND OF A HEATER YOU WANT.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.
HARTFORD CONNECTICUT

The straight tube heater has many advantage over the bent tube and not the least of these is the ease with which the tubes can be removed and replaced.

The Jacobs Patent Feedwater Heater and Purifier

has been in use so long and is so well know that its usefulness is not questioned, but we would like to send you our catalog just the same. We can save you money and want the chance to do so.

Chas. Jacobs & Co.
49 Oliver St.
BOSTON, MASS.

AGENTS
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639 Bourse Building
Philadelphia, Pa.
R. B. Murray
Farmers Bank Building
Room 511, Pittsburg, Pa.
Thos. G. Keogh,
434 Park Row Bldg., New York

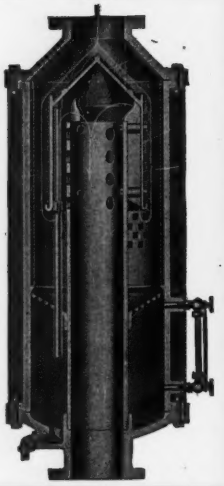
All The Time

Most separators take some water out of steam, and appear at times to be doing well, but very few remove all except one-half of one per cent **all the time**; for instance, when water is coming in quantities, they simply can't hold it, too small; or when steam is passing rapidly they have not sufficient surface to catch it, and these are just the times a separator is most needed. Send for catalog and investigate these points in

Direct Separator Co.

220 Marcellus Street,
SYRACUSE, N. Y.

Sweet's



Separators

THE STRATTON

Steam Separator

Will deliver **Dry Steam** to your engine under any and all conditions, no matter how long your steam pipe or how much your boilers may prime.

Separation takes place by the action of centrifugal force imparted to the steam. The large capacity not only provides for a sudden influx of water but forms a reservoir of steam which equalizes the pressure between boiler and engine, thereby increases the power and stops the vibration of steam pipes; a separator of small capacity is worse than useless, it is harmful.

SEND FOR CATALOGUE

***The* Goubert Mfg. Co.**

85 Liberty Street, NEW YORK
WORKS BAYONNE, N. J.

The Baum Separator

Horizontal Style for live Steam or Oil Service.

For Live and Exhaust Steam
RESULTS GUARANTEED

Repeat orders are the best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and are very much pleased with the results we are getting from it," writes one who has been using Baum Separators for several years.

Write for further information before placing order. A new catalog on request.

Vacuum Style Oil Extractor.

The Baum Separator and Machine Co., MANHEIM, PA.

Berryman

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for every Purpose and Condition

THE KELLEY PATENT
Improved Berryman Water Tube, Feed Water Heater and Purifier

BENJ. F. KELLEY & SON, Makers
120 Liberty Street, NEW YORK

THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.

Compound Separator

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

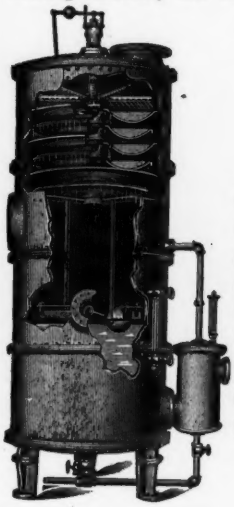
The Kutztown Foundry and Machine Co.

WORKS:

KUTZTOWN, PENNA.

Philadelphia Office: Fidelity Building, Broad above Arch Street.

THE principle upon which this heater operates, is different from the ordinary kind of heaters. If you will take the trouble to write for our catalog, and study the sectional views, you will see that the distribution of the water is such as to give the highest possible heating efficiency and that it is also a perfect purifier.



The Pittsburgh Feed-Water Heater and Purifier

removes the impurities before they enter the boiler—which is the right time to remove them. Hundreds of thousands of h. p. are now in use in the immense steel mills of Pittsburgh District where the hardest service and the worst water on earth are found and they are giving perfect satisfaction.

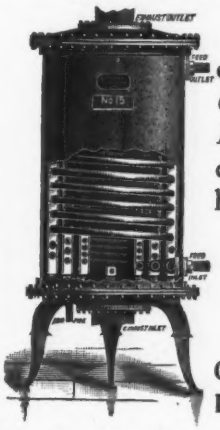
Write for NeW Heater Catalog which has just been Published

James Bonar & Co., Inc.

716 Frick Building Pittsburgh, Pa.

The National Feed-Water Heater

2,500,000 Horse Power in Daily Use



The principal characteristics of these heaters are *Simplicity, Cheapness, Reliability and Effectiveness,* and full amount of heating surface in every heater.

Supplies Water to the Boiler at 212° F.

We manufacture the Original and Only Genuine First-Class Coil Feed-Water Heaters.

We Also Manufacture All Kinds of Coils in Iron, Brass and Copper Pipe

Catalogue and Prices on Application.

Manufactured and Sold Only by

THE NATIONAL PIPE-BENDING CO.

157 Lloyd St. NEW HAVEN CONN.

THE GEMMEL PATENT BOILER

JAMES GEMMEL

Phones:—Bell, Market, 11-73 D Keystone, Main, 46-91 D

This Vertical Boiler possesses all the advantages of a Horizontal Boiler and none of its expensive disadvantages.

It requires only small floor space. It requires no expensive setting. It affords a natural path for the flue gases, and is a rapid steamer.

Its improved construction guarantees rapid circulation, and the highest degree of efficiency.

WRITE FOR ILLUSTRATED CIRCULAR AND PRICES

General Engineering Co.

764 Swanson St., Philadelphia, Pa.

ENGINEERS. BOILER MAKERS.

MACHINE BLACKSMITHING.

Machinery Repairs—Cylinders of Engines and Pumps Rebored in place. Stacks, Tanks and all kinds of Boiler Work.

There Are Reasons For It.

The Patterson-Berryman Feed Water Heater and Purifier

AND

The Patterson Belt Pump

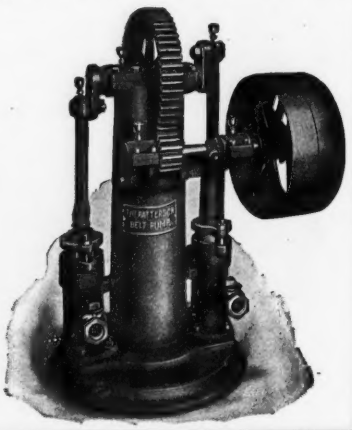
are sold on trial with the distinct understanding that they may be returned to us at our expense should either prove unsatisfactory. *Because*

They are manufactured of the best material and workmanship.

Their efficiency and durability is the highest.

They are simple in construction reducing repairs to the minimum.

If you are interested we would like to explain whys and wherefores.



Frank L. Patterson & Co.
24 Cortlandt Street,
NEW YORK

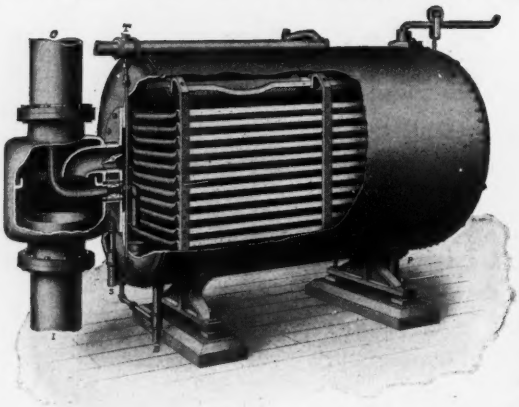
The PRINCIPLE is Different in The Hoppes

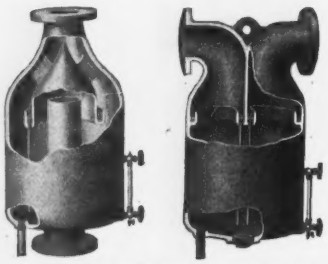
Hoppes Feed-Water Heaters

Bring the water and steam together in a manner that gives the **highest economy**, separates the **oil** from the exhaust and **purifies** the feed-water.

Made in steel plate for lime water and cast iron construction for acid waters to suit conditions.

Write for our catalogs.





Separators and Receivers made in all types and sizes.

Hoppes Heater, with Induction Chamber

Which often Saves the Cost of Heater in Pipe, Fittings, Valves and Space. Furnished **on order only** with either **Cast Iron** or **Steel** type of our heaters.

Hoppes Steam Separators give dry steam without wire drawing, as the smallest passage is over three times the area of the pipe.

Hoppes Oil Eliminators have never failed. Are guaranteed to positively remove the oil from your exhaust so as to prevent it getting into your boilers. Write for our catalogs.

HOPPES MFG. CO.
70 Larch Street, Springfield, O.

Hoppes Live Steam Feed-Water Purifiers

Keep Boilers Clean without "**dope.**" They also act as **reservoirs of energy** to help over **peak loads.** Used all over the world and recommended by leading engineers as the most economic method of **keeping boilers clean.** Water analysis made free for prospective customers.

Hoppes Cast Iron Exhaust Head that will not rust out.

U.S. Automatic Injectors

The U. S. Automatic Injector isn't "THE BEST" simply BECAUSE the U. S. Government adopted it. The U. S. Government adopted the U. S. Automatic because it is THE BEST.

Scientific tests prove that the U. S. Automatic has 100 per cent efficiency that it is ideally perfect, that there is absolutely no waste.

Continuous use has demonstrated the U. S. Automatic the most reliable and trustworthy Injector on the market. That's why over 200,000 engineers endorse it as the BEST.

NOTE THESE FACTS:—The U. S. AUTOMATIC has wider range, feeds hotter water, is the only injector with a drip cock—a mighty valuable feature, and the only injector accompanied by a bonafide certificate of range and capacity. Want more facts?

WRITE FOR THE ENGINEER'S RED BOOK——— SENT FREE!

This modest little booklet deals in facts—not theories It has proved helpful to thousands of engineers. It will prove valuable to you. Free for the asking.

American Injector Co.
Detroit Mich.

Chicago Automatic Injectors

Start low at 15 lbs. steam pressure. Work high to 160 lbs. and will handle from 120 to 125 degree water.

Are made strong, heavy and durable. Easy to connect and operate.

The UNITED STATES GOVERNMENT uses them on the Panama Canal.

Over 150 of the PRINCIPAL RAILROADS in the UNITED STATES, and all progressive steam users, use our INJECTORS and LUBRICATORS because they are reliable and give the best satisfaction.

WRITE FOR CATALOGUE

The Ohio Injector Co.

Largest Manufacturers of Injectors in the United States.

2128 MAIN STREET
WADSWORTH, OHIO, U. S. A.

A Christmas Present for Every Boiler

A resolution at this time to use only THE PENBERTHY AUTOMATIC INJECTOR will save trouble for the future. You will be in good company, as there are more Penberthy Automatic Injectors in use than all other makes combined.

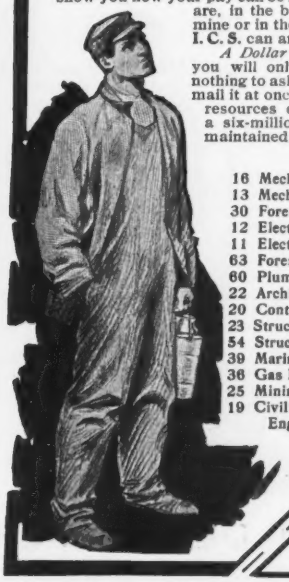
Our special Christmas number of the "Penberthy Engineer and Fireman," 64 pages, sent free on request. Year's subscription to regular 32-page issues, 25c.

PENBERTHY INJECTOR CO., 344 Holden Ave., Detroit Mich. U.S.A.
Largest Manufacturers of Injectors in the World
Made in Canada by The Penberthy Injector Co., Ltd., Windsor, Ont.

A Dollar An Hour
Instead of
A Dollar A Day

Don't be satisfied with a small salary all your life—do as thousands of others have done; let the **International Correspondence Schools** show you how your pay can be increased. It matters not where you are, in the boiler pit or in the engine room, in the mine or in the mill, in the office, store, or shop, the **I. C. S.** can and will increase your earning capacity.

A Dollar an Hour is not out of your reach, if you will only let us help you. It will cost you nothing to ask us—*How?* Clip and mark the coupon, mail it at once, and it will bring to your aid all the resources of that great institution—the **I. C. S.**, a six-million dollar establishment founded and maintained for the benefit of poorly paid men.



16 Mechanical Engineer	1 Bookkeeper
13 Mechanical Draftsman	2 Stenographer
30 Foreman Machinist	3 Ad Writer
12 Electrical Engineer	7 Illustrator
11 Electrician	9 Chemist
63 Foreman Steam Fitter	8 Civil Service Exams.
60 Plumbing & Heat. Con.	
22 Architect	
20 Contractor & Builder	
23 Structural Engineer	
54 Structural Draftsman	
39 Marine Engineer	
36 Gas Engineer	
25 Mining Engineer	
19 Civil Engineer	

International Correspondence Schools Box 835 **Scranton, Pa.**

Please explain, without further obligation on my part, how I can qualify for a larger salary and advancement to the position numbered_____

Name _____

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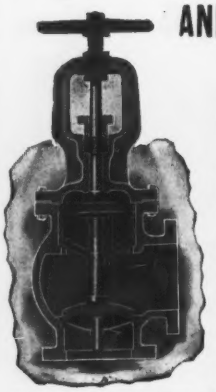
City_____ State_____



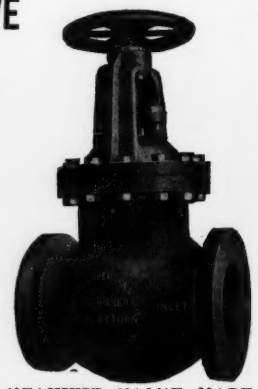
XX EXTRA HEAVY

ANDERSON PATENT CUSHIONED NON-RETURN VALVE

PROTECT YOUR BOILERS WITH AN ABSOLUTE SAFETY STOP

These Valves, when placed between the boiler and header, Equalize the pressure between the Different Units of a battery of boilers, as they remain Closed as long as the boiler pressure is Lower than that of the Header. When the boiler pressure Equals that of the head pressure, they Open and remain in that position without Chattering or Hammering. They automatically cut off a boiler in case of accident to boiler, such as bursting of a tube, and also act as a Safety Stop to prevent steam being turned into a cold boiler, which also means a safeguard for men working inside.

Then why endanger your power plant by using the regular Angle, Globe or Gate Valves at the boilers, when you can get the Anderson Cushioned Non-Return Valve, which is an Automatic Stop Valve, also a Hand Stop Valve, all in one. The sectional cut shows plainly the perfect Dash-pot arrangement for cushioning these valves, which is so Essential in order to avoid the Chattering and Hammering Existing in this class of Valves. The sectional cut also shows the inside Dash-pot attached to the valve spindle, whilst the outside Dash-pot is loose on the spindle, also FREE to move in the body.—in a word, a Corliss Dash-pot, occupying the full area of the body, thus absolutely insuring the perfect cushioning feature and the perfect alignment of the Valve. **"The Valves With an Absolute Guarantee," Where Is Their Equal?**

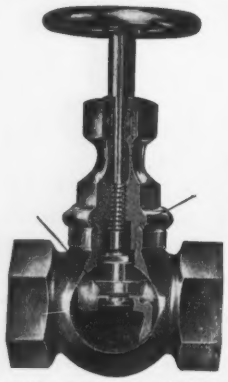


HEAVIEST VALVE MADE

The Golden "NON-CORROSIVE" "NON-SETTING" Steam Gauge

DOUBLE SEAMLESS BRASS AND STEEL DRAWN TUBES

Did you ever see a Steam Gauge with Double Seamless Brass and Steel Drawn Tubes? Here it is the most Accurate and Durable TUBES that have ever been designed for Gauge Service.—A Seamless BRASS TUBE within a Seamless STEEL TUBE, drawn and treated by a Secret Process, making them Non-Corrodible, non-setting, hence they are not effected by Vibration, Shock, or Crystilization that is so ruinous to Gauges. If you want the best and most reliable gauge made; no other gauge will fill your bill. Every tube is tested to 1000 pounds.



Golden "Clean Seat" Valve

The Golden "Clean Seat" Valve

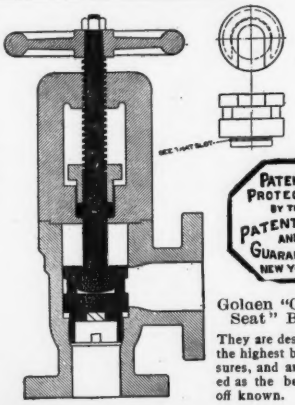
"BUILT FOR SERVICE"

IT CLEANS ITS OWN "SEAT AND DISC"

The bottom of disc is hollow, with solid cast eccentric lugs on the side. Slot or groove is cut between the lugs and entire outside diameter, so when the slot or groove comes flush with seat, steam, water, or air iets direct across the seat and disc. The heaviest, most economical and durable valve made. Also made for Hydraulic and compressed air service.

THE GOLDEN "CLEAN SEAT" BLOW OFF

is as simple and self-cleaning as the Globe and Angle valve. Body is iron fitted with renewable bronze seat and solid bronze valve or disc, with babbit or other flexible metal insertion that can be quickly refilled if found necessary.



PATENTS PROTECTED BY THE PATENT TITLE AND GUARANTEE CO. NEW YORK

Golaen "Clean Seat" Blow-Off

They are designed for the highest boiler pressures, and are regarded as the best blow-off known.

ANDERSON
PATENT
Float Valve

"Simply has no Equal!"

The Valve with an Absolute Guarentee

Cushioned in opening and closing. Float swivels to any angle desired. For high and low pressure. Absolutely controls the water level in tanks or reservoirs. Instantly adjusted to operate quick or slow, as desired. "No waste of water!" The upper portion of body being lined with bronze, also the valve or piston being solid bronze, makes the valve indestructible. Firms that are using them say, "their equal is not made."

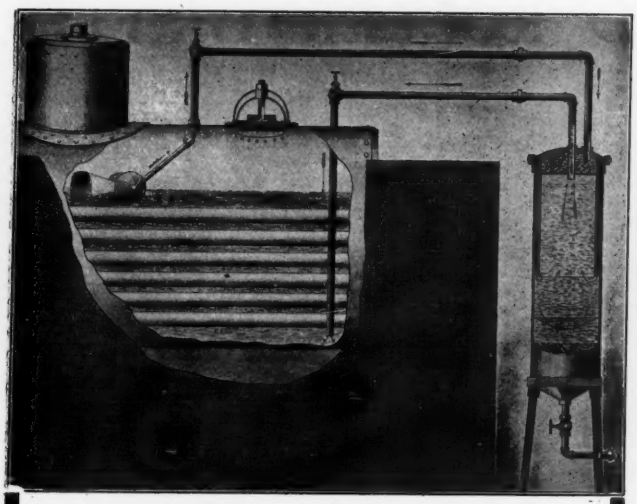
The Golden Patent High and Low Pressure Tilting Steam Trap

For all pressures, up to and including 275 pounds. A revolution in steam trap construction. One valve for all pressures and of enormous capacity. No FLOATS—NO VALVES—NO BUCKETS inside of traps; all working parts outside—compensating roller bearing in lever; no shock or jar, hence no wrenches required; simply tighten up trunnion nuts by hand is all that is necessary. We guarantee these Traps.

The heaviest line of AUTOMATIC VALVES and TRAPS ever presented to the trade.

GOLDEN-ANDERSON VALVE SPECIALTY CO.

107 SIXTH STREET PITTSBURG PA.



Seems Like A Joke

for power plant owners to continue buying chemicals to keep their boiler clean, or worse still, to permit scale to accumulate to the danger point—buying coal all the while to drive heat through it, and then buy expensive machines to grind it out, when the boilers can be kept clean all the time, and always at their maximum efficiency, by the use of a

Buckeye Boiler Skimmer

The difference between the Buckeye Skimmer and other so-called automatic devices is the difference between FAILURE and SUCCESS. The Buckeye is the only genuine automatic boiler-cleaner—the only one with a FLOATING Skimmer.

Read the following Extracts from Letters:—

CADICK MILLING CO., Grand View, Ind., Oct. 7, 1906.—"We are using Sterling water-tube boilers, and had quite a lot of troble with our boilers foaming and drawing over into the engine before placing your skimmers in them, but since we have installed your skimmers we have had no trouble at all. We are using very hard water, full of alkali, and the two boilers were as clean last wash-out day as if they had been cleaned out."

THE HALL & WOODS CO., Lima, Ohio, Nov. 14, 1906.—"The good service your boiler skimmers is doing us prompts us to write and tell you about it. We draw a trifle over a gallon of heavy, solid mud from the drum every day. We also find that the scale that was in our boilers before the skimmer was attached is being loosened."

LUCAS COUNTY INFIRMARY, Oct. 27, '06.—"I take pleasure in stating to you that the three Buckeye Automatic Skimmers we put in our boilers have given us entire satisfaction in fact, far beyond our expectations."

A Trial Costs Nothing

CATALOG FREE

The Buckeye Boiler Skimmer Co.
Colburn Ave.
Toledo, Ohio

The whole object in choosing a lubricating oil is economy—in fact, it should be the sole object—and no oil can be considered economical if it is not suited to the conditions under which it must lubricate.

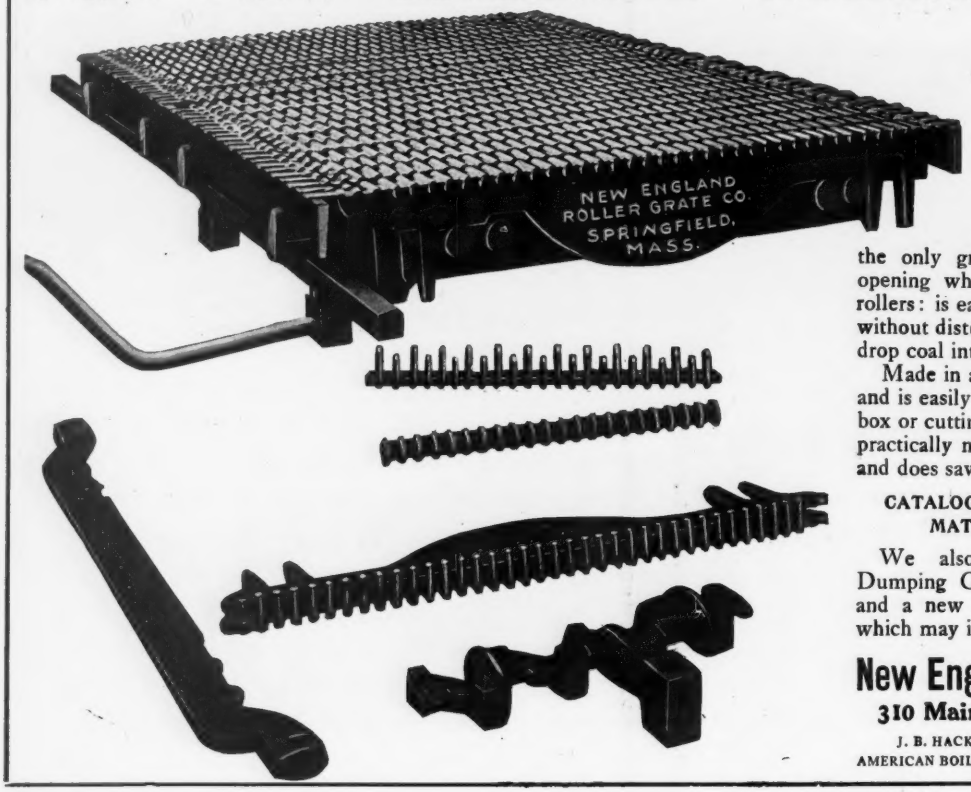
Our experience in providing oil to overcome frictional difficulties, brought about to a large extent by the high pressure, high temperature in use today, qualifies us to say that our advice will be of valuable assistance to any engineer who will consult with us on the subject of steam engine and cylinder lubrication. We do nothing on the hit-or-miss principle—oils that we suggest will lubricate properly under the most exacting conditions.

While the lubrication of an engine may seem satisfactory, we have found that in nine cases out of ten it can be improved upon. Not altogether in the operation but in the effect of the lubricant in over-coming friction and reducing inroads on the coal pile. Incidentally we suggest HARRIS VALVE OIL for the inside moving parts of an engine, HARRIS ENGINE OIL for the outside moving parts. Catalog and advice FREE.

A. W. HARRIS OIL CO.

320 South Water Street,
PROVIDENCE, R. I.

THE NEW ENGLAND ROLLER GRATE



NEARLY 6000 SETS IN USE IN NEW ENGLAND ALONE

THIS GRATE will burn any kind of coal and all of it. It has more air space than any other grate and is the only grate that does not change its opening when you shake it. It rests on rollers: is easy to shake: removes the ashes without disturbing the surface and does not drop coal into ash pit.

Made in all sizes, for all types of boilers and is easily installed without changing fire box or cutting away of boiler front. It costs practically nothing for repairs and it must and does save fuel.

CATALOGUE AND FURTHER INFORMATION FOR THE ASKING

We also manufacture Shaking and Dumping Grates, either round or square, and a new type of Stationary Grate Bars which may interest you.

New England Roller Grate Co.
310 Main St., Springfield, Mass.

J. B. HACKETT, Temple Court Building, New York
AMERICAN BOILER ECONOMY CO., Mutual Life Bldg. Phila

THE ENGINEER who is content with any old thing, who possesses neither pride nor foresight, and who doesn't care whether his plant is up-to-date or not, will not be interested in this, but every engineer who studies for economy and better results, knows that the boiler room is the place for his best attention. He wants a steady fire with practically perfect combustion and no black smoke, but, does he get it? Not with the old method of hand firing.

Wilkinson Stoker

feeds the fuel regularly as required without opening the fire doors to admit cold drafts. Any boiler will last twice as long if fired with a Wilkinson. Saves fuel, repair bills and its own cost.

Wilkinson Manufacturing Co., Bridgeport, Montgomery County Pa.

" The World's Greatest Lubricant "

A Large Size Sample Can of Keystone Grease, **FREE** A Heavy Brass Grease Cup, also Engineer's Cap.

Why do this, because we find the most forceful logic and subtle argument we can put forth about Keystone Grease will never do the work that a little experience on the part of the engineer in testing it himself will do. All we ask is an engineer's name and business address to insure delivery and an answer to the following questions :—

H. P. of engine, R. P. M. of crank pin, on what bearing and width of bearing he will test Keystone Grease and to give us size of tap that we can send cup to fit. Remember no charge now or afterward.

One pound of Keystone Grease will lubricate better and last longer than 3 to 4 pounds of any other grease or 4 to 6 gallons of high-grade oil.

KEYSTONE LUBRICATING CO.

Address Dept. F., Philadelphia, Pa.

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30 Oliver Street, Boston, Mass.

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"THE MONARCH"
SCREW END BRONZE GATE VALVE

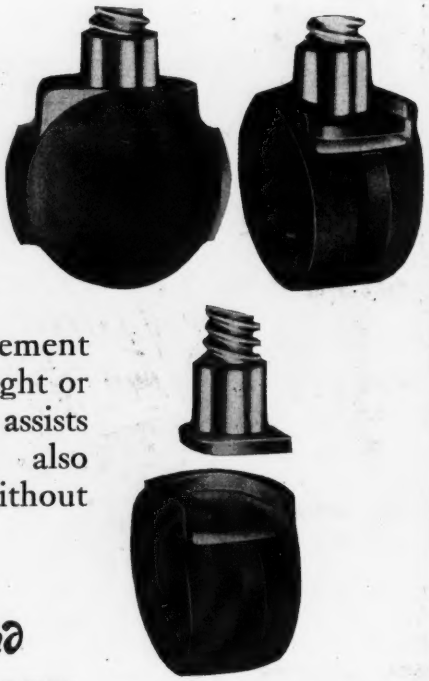
The Monarch Is The King Of Valves

Superior design, workmanship and material. Strong where strength is most needed and no waste metal elsewhere.

The loose neck arrangement permits changing from left to right or vice-versa; relieves strains and assists in obtaining a perfect seat, also permits renewal of parts without disconnecting.

Monarch Valve *and* Manufacturing Company

WARREN, MASS.



PLUG (OR GATE) AND LOOSE NECK ARRANGEMENT

HOMESTEAD

Three Way Valve

with internal locking device requiring one-third turn of plug to lock at both ends of turn, for any pressure. Largely used in steel mills and other plants

Homestead Three-Way Valve. This is the best Three-Way Valve on earth.

Homestead Valve Manufacturing Company

Brass Founders

P. O. Box 1754 Pittsburg, Pa.

Works at Homestead, Pa.

One of these Four-Way Metallic Valves was opened and closed 9,125,000 times.

A one and one-fourth inch Homestead Four-Way valve used in operating a blast furnace at the Duquesne Mills was in constant service nights and days and Sundays for over four years without a repair. During that time it was opened and closed 9,125,000 times.

Write for Illustrated Catalogue

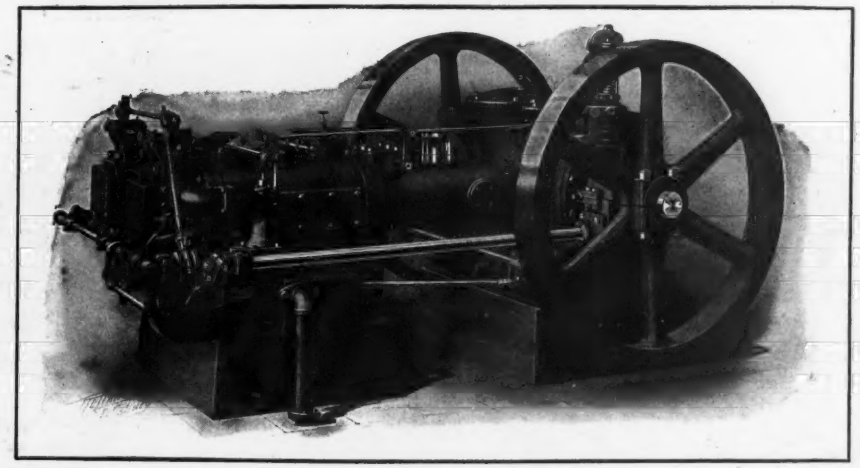
THE BUCKEYE GAS ENGINE

SIMPLE, ECONOMICAL, DURABLE

ESPECIALLY ADAPTED TO DRIVING ELECTRIC GENERATORS

BUILT BY **BUCKEYE ENGINE CO., SALEM, OHIO**

TYPES	POWERS
SINGLE ACTING TWO-STROKE CYCLE	25 H. P. TO 500 H. P.
DOUBLE ACTING TWO-STROKE CYCLE	500 H. P. TO 6000 H. P.
DOUBLE ACTING FOUR-STROKE CYCLE	500 H. P. TO 6000 H. P.



WE STILL MAINTAIN OUR REPUTATION FOR INDEPENDENT THOUGHT AND ACTION AND FOR KEEPING ABREAST OF THE TIMES, AND IN PRESENTING THE BUCKEYE GAS ENGINE, ENGINEERS AND PURCHASERS WILL NOTE THAT WE ARE ORIGINATORS AND LEADERS IN THIS NEW LINE AS WE ALWAYS HAVE BEEN IN OUR STEAM ENGINE PRACTICE.

WE CUT FROM NEW CLOTH.

WRITE US WHEN WANTING EITHER GAS OR STEAM ENGINES.

PIPE COVERING

Nonpareil Cork—Asbestos Magnesia Wool Felt and Hair Felt

SHEET CORK For Cold Storage Insulation

PLANS AND ESTIMATES ON COMPLETE INSULATION FOR COLD STORAGE WORK

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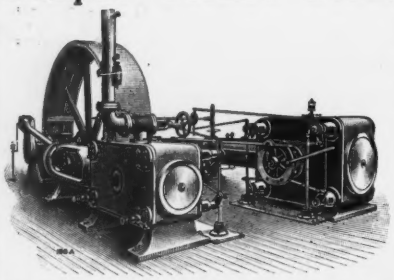
Eclipse Corliss Steam Engines

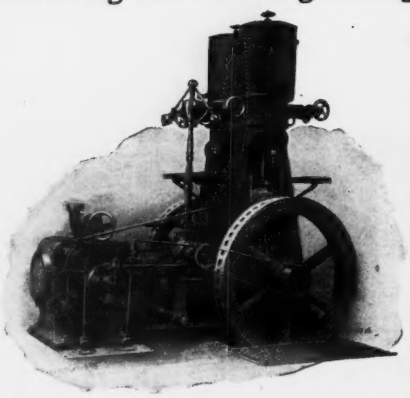


Simple, Tandem and Cross Compound—Condensing and Non-Condensing

MAINTENANCE, REGULATION, DURABILITY AND ECONOMY

Fully Guaranteed

Eclipse Ice-Making and Refrigerating Machinery



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Complete Equipments for Ice Manufacture

Entire Installation of Mechanical Refrigerating

Systems for Packing Houses, Breweries, Cold Storage Warehouses

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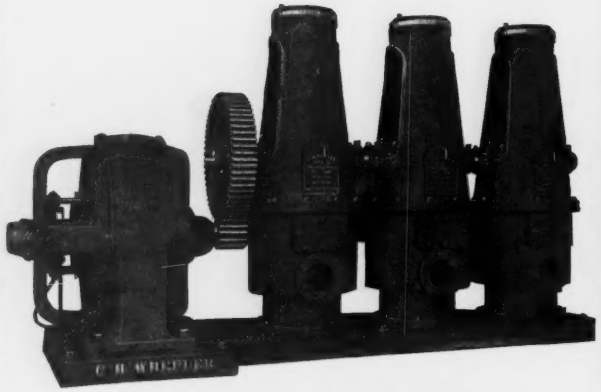

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SUCTION VALVELESS

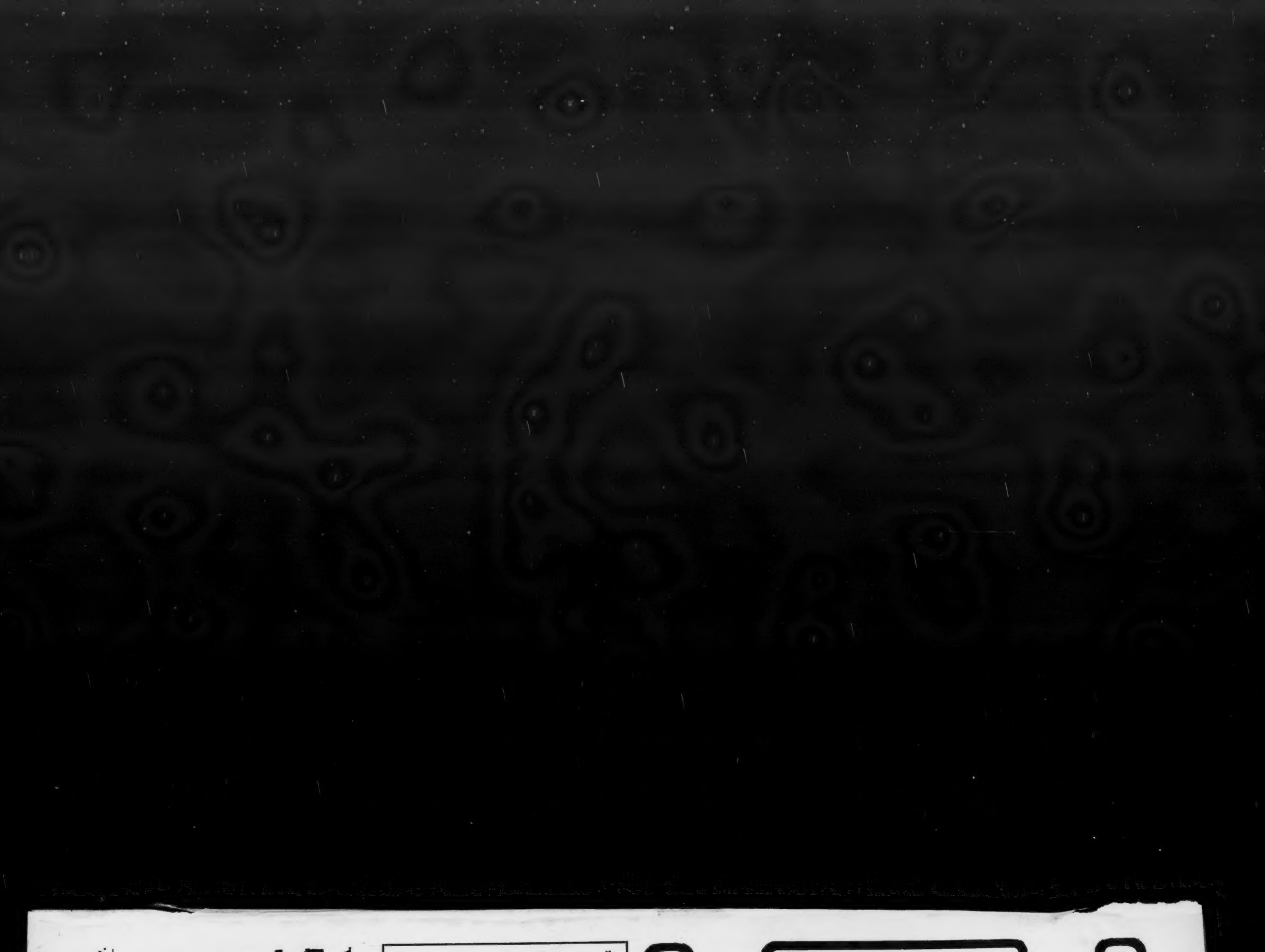
AIR PUMP

Maintains the Highest Vacuum under all conditions. Horizontal and Vertical Designs, Single, Duplex and Triplex.

GET ONE FREE

Put it on your boiler, and give it a good trial for a month; if it gives you absolute satisfaction, keep it, and pay for it, otherwise send it back at our expense.

"P. B. H." WEIGHT GAUGE COCK

There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

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